THIS SLIDING-RULE, and all Sorts of INSTRUMENTS, uſeful in Gauging, Surveying, Dialling, and all Practical Parts of MATHEMATICKS, are made to the greateſt Exactneſs, and ſold at the moſt reaſonable Prices, by JOHN COGGS, at the *Globe* and *Sun*, between St. *Dunſtan*'s Church and *Chancery-Lane* in *Fleetſtreet*, *London*.

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Practical Gauging

IMPROVED,

By the Help of a New

Portable Sliding-Rule.

Know when the

Practical Gauging
IMPROVED,
By the Help of a New
Portable Sliding-Rule,
Which performs all the
OPERATIONS
OF
Mr. EVERARD'S RULE
IN
A more Exact Manner, the Single RADIUS being Eight Foot long.

By THO. HILL, Philomath.

LONDON:
Printed for H. LINTOT, at the *Croſs-Keys* againſt *S. Dunſtan's* Church in *Fleetſtreet.*
M.DCC.XXXIV.

TO THE

HONOURABLE

CHRISTOPHER MOUNTAGUE,
JOHN WHETHAM,
ROGER GALE,
CHARLES POLHILL,
JOHN FOWLE,
THOMAS WYLDE,
JAMES VERNON,
ROBERT EYRE,
HUMPHRY THAYER,

Esqrs;

Chief Commissioners and Governors for the Management and Receipt of His MAJESTY's Revenue of Excise within the Kingdom of *England*, &c.

THOMAS HILL

Humbly Dedicateth this

TREATISE.

PREFACE.

THE *Uſefulneſs and Advantage of Mathematical Learning in general, and eſpecially thoſe moſt excellent Sciences* Arithmetick *and* Geometry, *are ſo well known, that, I preſume, I need not ſay any thing to perſuade to the Study thereof: By theſe, many Arts have been invented or improv'd; one Inſtance of which is the Invention of the* Logarithms

rithms *by my Lord* Napier: *These* Logarithms *were diſpos'd into a Line by Mr.* Gunter.; *after him Mr.* William Oughtred *diſpoſed this Line in a Circle, thereby enlarging the Diviſions, and ſeveral others have attempted the ſame Thing by other Methods: Mr.* Everard *afterwards contriv'd a Sliding-Rule, thereby performing all the Operations that are work'd by the Lines, without the help of Compaſſes; and ſince that time ſome Improvements have been made, yet ſtill thoſe Rules, as they are commonly uſed of ſhort Lengths, do but at beſt help to gueſs at the Truth, by reaſon the Diviſions are ſo cloſe.*

The PREFACE.

IT *was this Consideration that put me upon contriving a* SLIDING-RULE *(of one Foot Length when shut) that very considerably augments the Divisions, which, I conceive, will be very useful to those who are concern'd in His Majesty's Excise, the Divisions on this Rule being almost Nine times larger than those on the common Rule of one Foot Length, whereby the Gauger may find the Place of* Four Figures.

I AM *sensible that several ingenious Tracts on the Subject of Gauging have been published by Men of Learning and Merit, and therefore should have thought this altogether needless, if the Use of the Rule herein*

in

in treated of (being different from any other) had not absolutely required it. I have confined myself to the Practical Part of Gauging only, and to that Purpose have consulted Mr. Everard's, *Mr.* Ward's, *and Mr.* Dougharty's *Writings on the Subject, leaving the Curious to the Authors themselves who have handled the Art of Gauging more largely.*

Practical Gauging

IMPROV'D, by the Help of a

NEW SLIDING-RULE.

Of Decimal Arithmetick.

EVERY one that designs to understand the Art of Gauging, ought to be well acquainted with the Principal Rules of Arithmetick; especially Multiplication and Division, both in Whole Numbers and Decimal Fractions; the latter of which is most useful in this Art.

Notation of Decimals.

AN Unit or Integer is one whole Thing, as one Pound, one Inch, one Gallon.

A Fraction is a part or parts of an Unit or whole Number, and conſiſts of two Numbers, *viz.* Numerator and Denominator.

The Denominator ſhews into how many parts the Unit is divided, and the Numerator expreſſes how many of thoſe parts are intended by the Fraction.

A Decimal Fraction is an artificial way of expreſſing Vulgar Fractions, by ſetting down the Numerators only; the Denominators being underſtood; and is always a Unit with as many Cyphers annexed as there are Places in the Numerator; and therefore muſt be either 10, 100, 1000, 10000, *&c.*

A Decimal Fraction is known from a Whole Number by a Point before it thus .5.

As whole Numbers increaſe by a Tenfold Proportion from the Unit's Place to the Left Hand; ſo Decimals decreaſe by the ſame Proportion, from Unity to the Right Hand, as may be ſeen in the following Table.

Integers.							Decimals.					
Millions.	C of Thouſands.	X of Thouſands.	Thouſands.	Hundreds.	Tens.	Units.	Tenth Parts.	Hundredths.	Thouſandths.	X Thouſandths.	C Thouſandths.	Millions of Parts.
7	6	5	4	3	2	1.	2	3	4	5	6	7
Seventh Place	Sixth Place	Fifth Place	Fourth Place	Third Place	Second Place	Units.	Primes - - -	Seconds - -	Thirds - - -	Fourths - - -	Fifths - - -	Sixths - - -
Integers, or whole increaſing Numbers.							Decimals, or Fractional decreaſing Numbers.					

Here the Figure 2 in the Integers, ſignifies 2 Tens or twice 10 Units; but the Figure 2 in the Decimals, ſignifies but 2 Tenths of Unity.

The Order of Places in Decimals is from Left to Right, and therefore contrary to the Order of Places in a whole Number, which is from Right to Left, as in this Decimal .628, the Figure 6 ſtands in the firſt Place, and is 6 Primes or 6 Tenths of an Integer; 2, the ſecond Figure, is 2 Seconds or 2 Hundredth Parts of an Integer; and 8,

the third Figure, is 8 Thirds, or 8 Thouſandth Parts of an Integer.

Cyphers before whole Numbers, and after Decimals, are of no Value; but after whole Numbers, and before Decimals, they have their Value: For in whole Numbers they increaſe, and in Decimals they decreaſe the Value of the Figures join'd with them. For 5 and 05 and 005 in whole Numbers is ſtill but 5; but in Decimals, 5, by having a Point prefixed before it thus .5, is decreaſed from 5 Integers to $\frac{5}{10}$ of an Integer, and .05 to 5 Hundredth Parts of an Integer, *&c.* Again, in whole Numbers, 40 is Forty, and 400 is Four Hundred; but in Decimals, .40 or .400 is ſtill but $\frac{4}{10}$ of an Integer.

Addition and Subtraction of Decimal Fractions.

AS to the manner of Adding and Subtracting, 'tis the ſame as in common Addition and Subtraction; only you muſt always remember to ſet Units under Units, and Tenths under Tenths, *&c.* See the following Examples.

.436	3.27	87.6
.27	.76	492
.541	4.2	.48
Sum 1.247	Sum 8.23	Sum 93.00

From

From	.843	From	85.328
Subtract	.527	Subtract	9.84
Remains	.316	Remains	75.488

In all theſe Examples you may obſerve, that the Points in the Sums and Remainders ſtand juſt under the Points in the Number given; and there muſt be always as many Places of Fractions in the Sum or Remainder, as are found in any of the Sums to be added or ſubtracted.

A Table of Ale Meaſure.

Cub. Inch.	*Gallon*	*Firkin*	*Kild.*	*Barrel*	*Hog ſhead*
282	1				
2256	8	1			
4512	16	2	1		
9024	32	4	2	1	
13536	48	6	3	$1\frac{1}{2}$	1

A Table of Beer Meaſure.

Cub. Inch.	*Gallon*	*Firkin*	*Kild.*	*Barrel*	*Hog ſhead*
282	1				
2538	9	1			
5076	18	2	1		
10152	36	4	2	1	
15228	54	6	3	$1\frac{1}{2}$	1

Note, This Difference between Ale and Beer Measure is now only used in *London*. But in all other Places of *England*, the following Table of Beer or Ale is to be observed, according to a Statute of Excise made in the Year 1689.

A Table of Ale or Beer Measure.

Cub. Inch.	*Gallons*	*Firkins*	*Kilder.*	*Barrels*	*Hogsheads*
282	1				
2397	$8\frac{1}{2}$	1			
4794	17	2	1		
9588	34	4	2	1	
14382	51	6	3	$1\frac{1}{2}$	1

A Table of Wine Measure.

Cub. Inch.	*Gallons*	*Tierces*	*Hogsheads*	*Puncions*	*B. or P.*	*Tons.*
231	1					
9702	42	1				
14553	63	$1\frac{1}{2}$	1			
19404	84	2	$1\frac{1}{3}$	1		
29106	126	3	2	$1\frac{1}{2}$	1	
58212	252	6	4	3	2	1

Ex-

Examples of Ale or Beer Measure.

Bar.	*Fir.*	*Gal.*	*Bar.*	*Fir.*	*Gal.*
64	3	5.4	48	2	6.1
48	3	6.6	74	3	4.6
74	2	4.1	18	3	5.4
69	2	3.2	31	2	3.7
46	3	7.3	14	2	2.2
Sum 305	0	1.1	188	2	5

In these Examples you are for every 8.5 Gallons to carry one Firkin to the Line of Firkins, and for every 4 Firkins to carry one to the Barrels.

A Table of Dry Measure.

Cub. Inches	*Gallons*	*Pecks*	*Bushels*	*Quarter*
268.8	1			
537.6	2	1		
2150.4	8	4	1	
17203.2	64	32	8	1

Every round Bushel with a plain and even Bottom, being made eighteen Inches and a half wide throughout, and eight Inches deep, should be esteem'd a legal *Winchester* Bushel, according to the Standard in his Majesty's Exchequer. Now a Vessel being thus made will contain 2150.42 Cubick Inches.

Multiplication of Decimals.

IN Multiplication of Decimals, both the manner of placing and multiplying is in all reſpects the ſame with whole Numbers, only it muſt be obſerved to cut off as many Figures (towards the Right Hand) from the Product as there are Decimal Places in both the Multiplier and Multiplicand; but if the Product have not ſo many Figures as there ſhould be Decimal Places, you muſt add as many Cyphers on the Left Hand of the Product as will make up the Number of Places.

EXAMPLES.

837	4.231
2.35	4.28
4185	33848
2511	8462
1674	16924
1966.95	18.10868
.246	.116
.13	.071
738	116
246	812
.03198	.008236

Diviſion

Diviſion of Decimals.

DIviſion of Decimals is work'd juſt as it is in whole Numbers, only when the Work is over, you muſt point off as many Places from the Quotient for Decimal Parts, as the Dividend has more than the Diviſor; but if the Quotient have not ſo many Figures as there ſhould be Decimal Places in it, you muſt put as many Cyphers on the Left Hand of the Quotient as will make up the Number of Places.

Note, You may find the Value of the Remainder to what Exactneſs you pleaſe in Decimal Places, by adding Cyphers to the Dividend. In common Caſes, the Difference between the Number of Decimal Places in the Dividend and Deviſor ſhould be three or four, ſometimes there is requir'd ſix or more.

Examples in all the Caſes.

147) 346.000 (2.353

Note, In this Example the Cyphers were added to find the Value of the Remainder in Decimal Places.

371) 43.7600 (.1179
5.32) 832.00000 (156.390
.76) 536.00000 (705.263
3 97) 42.70000 (10.755
.231) 57.820000 (250.303
822) .237600 (.000289
76.2) .476827 (.00625
.795) .847643 (1.066

Note, The Cyphers were added in these Examples to make the Decimal Places in the Dividend exceed those in the Divisor, and to come nearer the Truth.

Reduction of Decimals.

TO reduce a Vulgar Fraction into a Decimal Fraction equivalent to it.

Rule { As the Denominator of the Vulgar Fraction
Is to its Numerator,
So is 10, 100, 1000, *&c.*
To the Numerator of the Decimal Fraction.

Or, which is the same, annex Cyphers to the Numerator and divide by the Denominator.

EXAMPLE I.

What Decimal Part of a Barrel of Beer is 9 Gallons?

There are 34 Gallons in one Barrel, and therefore 9 Gallons are $\frac{9}{34}$ of a Barrel.

Then the Proportion is

as 34 : 9 : : 10000

9

34) 90000 (2647

68

220

204

160

136

240

238

2

Answer .2647

EXAMPLE II.

What Decimal Part of a Pound Sterling is 17 *s.* 8 *d.*

In one Pound is 240 Pence, and 17 *s.* 8 *d.* is 212 Pence, therefore the Vulgar Fraction is $\frac{212}{240}$, then

240) 2120000 (8833
1920
2000
1920
800
720
800
720
80

Answer .8833

E X.

EXAMPLE III.

What Decimal of a Foot is one Inch?

There are 12 Inches in one Foot, therefore the Vulgar Fraction is $\frac{1}{12}$, and

```
12) 10000 (833
    96
   ----
     40
     36
   ----
     40
     36
   ----
      4
```

Anſwer .0833

To find the Value of a Decimal Fraction in the known Parts of Money, Weight, Meaſure, &c.

Multiply the given Decimal by the Parts of the next leſſer Denomination that is equal to the Integer the Decimal gives the Part of, and from the Product cut off ſo many Figures toward the Right Hand as there are Places in the given Decimal, the remaining Figures on the Left Side are the Value of the ſaid Decimal; if any thing remain, it is the Decimal of an Integer in the Denomination laſt found, and may be reduced as low as you pleaſe by the ſame Rule.

EX-

EXAMPLE I.

How much is .537 of a Pound Sterling?

20

10.740 Shillings

12

8.880 Pence

4

3.520 Farthings

	s.	*d.*	*q.*
Anſwer	10	8	3.52

EXAMPLE II.

How much is .031 of a Pound Sterling?

20

.620 Shillings

12

7.440 Pence

4

1.760 Farthings

	s.	*d.*	*q.*
Anſwer	00	07	1.76

EXAMPLE III.

How much is .624 of a Hundred Weight Averdupoize?

4

2.496 Quarters
28

3968
992

13.888 Pounds

Qrs. Pounds.
Answer 2 : 13.888

EXAMPLE IV.

How much is .437 of a Barrel of Beer?

4

1.748 Firkins
8.5

3740
5984

6.3580 Gallons
8

2.8640 Pints

Firk. Gal. Pints.
Answer 1 6 2.864

A brief

A brief Way of discovering the Value of any Decimal of a Pound Sterling.

The Figure in the first Place, or Place of Primes, being doubled, gives you the Number of Shillings, and the next two Figures being accounted one entire Number, and made less by 1 if above 13, or made less by 2 if above 39, will be so many Farthings, which said Shillings and Farthings are the Value of the given Decimal: But if the Figure in the second Place be 5, or exceed 5, you must reckon one Shilling for the 5, and for the Excess above 5, esteem every Unit to be Ten, as before.

EXAMPLE V.

How much is .428 of a Pound Sterling?

	s.	*d.*
Answer	8	$6\frac{3}{4}$

EXAMPLE VI.

How much is .896 of a Pound Sterling?

	s.	*d.*
Answer	17	11

Note, The Half of any thing is .5, One Quarter is .25, One Third is .333, *&c.* Two Thirds is .666, *&c.* Three Quarters is .75.

Questions

Questions in the Rule of Three.

IF the Duty of 26 Barrels of Beer be worth 5 *l.* 14 *s.* what is the Duty of 47.6 Barrels?

Bar. *Pounds.* *Bar.*
If 26 give 5.7, what will 47.6 give?

```
                5.7
              ------
              3332
             2380
            ------
26) 271.320 (10.435
    26
    ---
     113
     104
     ---
      92
      78
      --
     140
     130
     ---
      10
```

l. *s.* *d.*
Answer 10 8 $8\frac{1}{2}$.

If

If 6 Quarters of Malt make 14 Barrels of Beer, how many Quarters of Malt will make 26 Barrels of such Beer?

B. *Qrs.* *B.*
If 14 give 6, what will 26 give?

6

14) 156.000 (11.142
14 8
16 1.136
14
20
14
60
56
40
28
12

Qrs. *Bush.*
Answer 11 1.136

If a Veſſel contain 37 Gallons of Ale, how many Gallons of Wine will it hold?

Cub. Inch. Gall. *Cub. Inch.*
If 282 give 37, what will 231 give?

37

1974
846

231) 10434.000 (45.168
924 8

1194 1.344
1155

390
231

1590
1386

2040
1848

192

Gall. *Pints.*
Anſwer 45 1.344

Having

If 6 Quarters of Malt make 14 Barrels of Beer, how many Quarters of Malt will make 26 Barrels of such Beer?

B. *Qrs.* *B.*

If 14 give 6, what will 26 give?

6

14) 156.000 (11.14

14

16

14

20

14

60

56

40

28

12

1.136

Qrs. *Bush.*

Answer 11 1.136

If a Veſſel contain 37 Gallons of Ale, how many Gallons of Wine will it hold?

Cub. Inch. Gall. *Cub. Inch.*

If 282 give 37, what will 231 give?

```
  37
 ----
1974
 846
 ----
231) 10434.000 (45.168
  924             8
 ----            ---
 1194           1.344
 1155
 ----
  390
  231
 ----
 1590
 1386
 ----
 2040
 1848
 ----
  192
```

	Gall.	*Pints.*
Anſwer	45	1.344

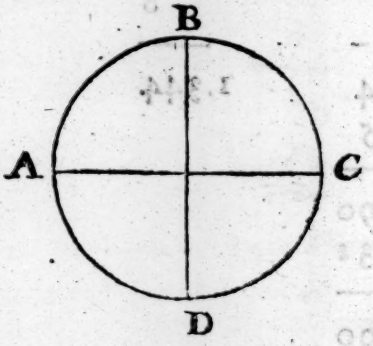
Having

Having the Diameter of any Circle given to find its Circumference.

Rule { Say, As 1 is to 3.1416, so is the Diameter to the Circumference.

EXAMPLE.

Suppose the Diameter AC of the Circle ABCD be 40 Inches, what is the Circumference?



As 1 : 3.1416 : : 40

40

125.6640 The Circumference required.

Having the Circumference of any Circle given, to find the Diameter.

Rule { Say, As 3.1416 is to 1, so is the Circumference to the Diameter.

EXAMPLE.

Suppose the Circumference of a Circle be 85 Inches, what is the Diameter?

As 3.1416 : 1 : : 85

3.1416) 85.0000000 (27.056 the Diameter required.
62832

221680
219912

176800
157080

197200
188496

8704

The Diameter of any Circle being given in Inches, to find the Area in Inches.

Rule { Multiply the Square of the Diameter by 0.7854, and the Product will be the Area in Inches.

EX-

EXAMPLE.

Suppose the Diameter of a Circle be Inches, What is its Area in Inches?

32 Diameter
32

64
96

1024
.7854

4096
5120
8192
7168

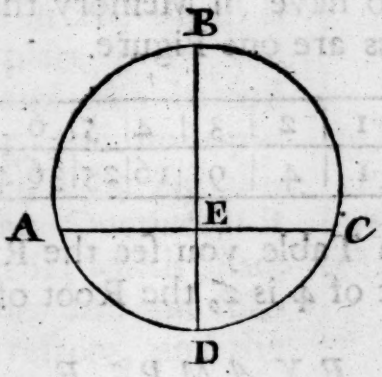
804.2496 The Content required.

Having the Depth of a Segment of a Circ and the Diameter of its Base, to f the Diameter of the Circle of which is a Segment.

Rule { Divide the Square of half the Fr trum's Base by the Depth, and t Quotient is the Depth of the ot Segment, which added to the giv Depth, is the Diameter of the Cir

EXAMPLE.

Suppoſe the Depth E D be 10 Inches and the Diameter at the Baſe A C= 24 Inches, What is the Diameter B D?



12 half the Fruſtrum's Baſe
12

24
12

10) 144(14.4 = B E
10 = E D

24.4

So that the Diameter B D is 24.4 Inches.

To

To Extract the Square Root.

TO Extract the Square Root of any Number, is to find a Number which multiplied into itſelf ſhall produce the given Number; and in order thereto it will be neceſſary to have in Memory theſe Squares whoſe Roots are one Figure.

Root	1	2	3	4	5	6	7	8	9
Square	1	4	9	16	25	36	49	64	81

In which Table you ſee the Root of 1 is 1, the Root of 4 is 2, the Root of 9 is 3, &c.

EXAMPLE.

Suppoſe the Square Root of 36864 were required;

Firſt, The Figures being ſet down and a Quotient Line drawn as in Diviſion, place a Point over the Place of Units, and ſo on over every other Figure towards the Left Hand, as you ſee under, and ſo many Points there be, ſo many Figures will your Root have.

36864 (

Then find the Root of the next leſſer Square under 3, which is 1, place it in the Quotient, and alſo the Square of 1, *i. e.* 1 under 3, and ſubtract it therefrom, and the Remainder is 2.

Then

Then to the Remainder 2 bring down the Figures to the next Point 68, and then there will be this Number 268, which I call a Reſolvend: Now for a Diviſor, double the Root 1 in the Quotient, which is 2, and 26 is called a Dividend.

Then ſeek how often you can have 2 in 26, which is 9 times, place 9 in the Quotient and alſo behind the Diviſor, and multiply this 29 by 9 (the laſt Figure in the Quotient) it produceth 261, which place orderly under 268 and ſubtract it therefrom, and the Remainder is 7.

```
 36864 (192
   1
  ---
29)268
   261
  ----
382) 764
      764
     ---
       0
```

Then to the Remainder 7 bring down the Figures to the next Point 64, ſo will there be a new Reſolvend 764; then double 19 the Root in the Quotient, whoſe double is 38, for a Diviſor, and 76 is a Dividend.

Then ſeek how many times you can have 38 in 76, which is 2 times, place 2 in the Quotient, and alſo behind the Diviſor and it makes 382, which multiplied by 2, the laſt Figure in the Quotient, produceth 764, which ſubtracted out of 764, the Remainder is 0; and thus the Work of Extraction being finiſhed, I find the Root of 36864 to be 192; and ſo muſt you proceed gradually Step

by Step, if the Number given consists of more Figures.

But when a whole Number hath not a Root exactly expressible by any rational or true Number, you may annex to the given Number as many Pairs of Cyphers as you please, as 00, 0000, 000000, *&c.* and then extract as before directed, and your Root will always have as many Decimal Places in it as there are Pairs of Decimals in the Square.

Note, If the Number of Decimal Places in the Square given be odd, you must add a Cypher on the Right Side of the given Square.

EXAMPLE.

```
. . . . . .
364972.874000 (604.129
36
----
1204) 04972
      4816
      ----
12081)  15687
        12081
        -----
120822)  360640
         241644
         ------
1208249)11899600
        10874241
        --------
         1025359
```

The Use of the Square Root.

Prob. I.

Two Numbers 24 *and* 384 *given, to find a Mean Proportional between them.*

Multiply one of the given Numbers by the other, and extract the Square Root of the Product, it gives 96, the Mean Proportional required.

Prob. II.

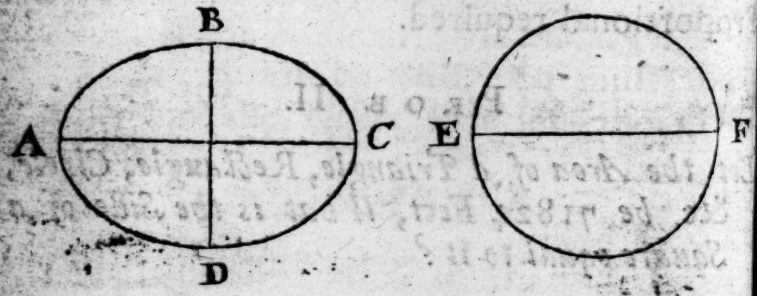
Let the Area of a Triangle, Rectangle, Circle, &c. be 71824 *Feet, What is the Side of a Square equal to it?*

Extract the Square Root of the given Area, it gives 268 Feet, the Side of the Square required.

Prob. III.

To find the Diameter of a Circle which shall be equal in Area to any Oval whose longest and shortest Diameters are given.

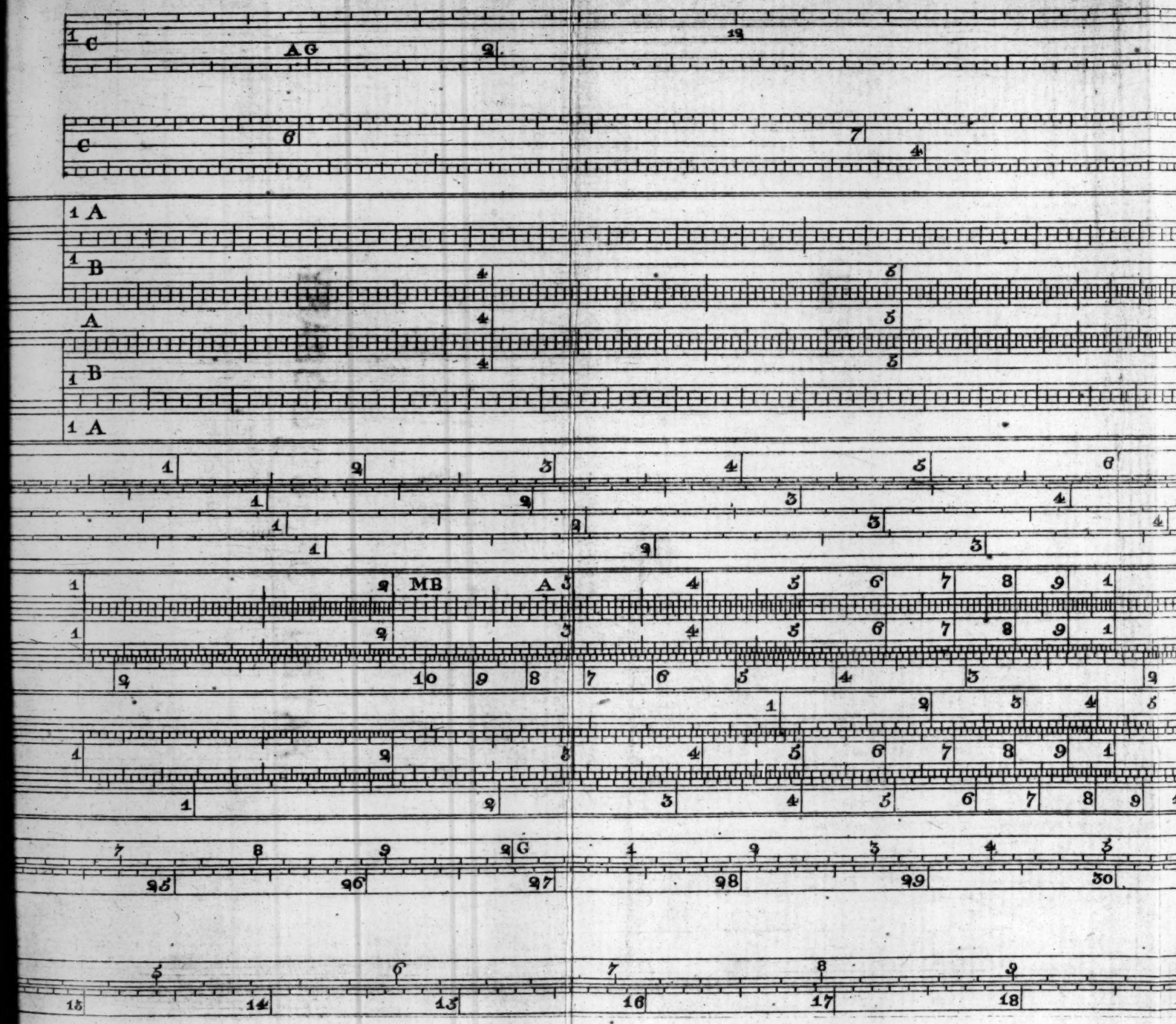
Multiply the longest Diameter A C = 48 Inches, by the shortest Diameter B D = 30 Inches, and extract the Square Root of



1440 the Product, which Root 37.94 Inches, is the Diameter E F of the Circle whose Area is equal to the Oval.

The Description and Use of a New-Invented Sliding-Rule, *and of the Lines upon it.*

THE Rule consists of 3 Parts, *viz.* A Rule of 12 Inches long, with two small Scales to slide in it on one Side of the Rule, all opening to 2 Foot long; the Slides may be drawn out one towards the Right Hand and


C
AG
C
A
B
A
B
A
MB
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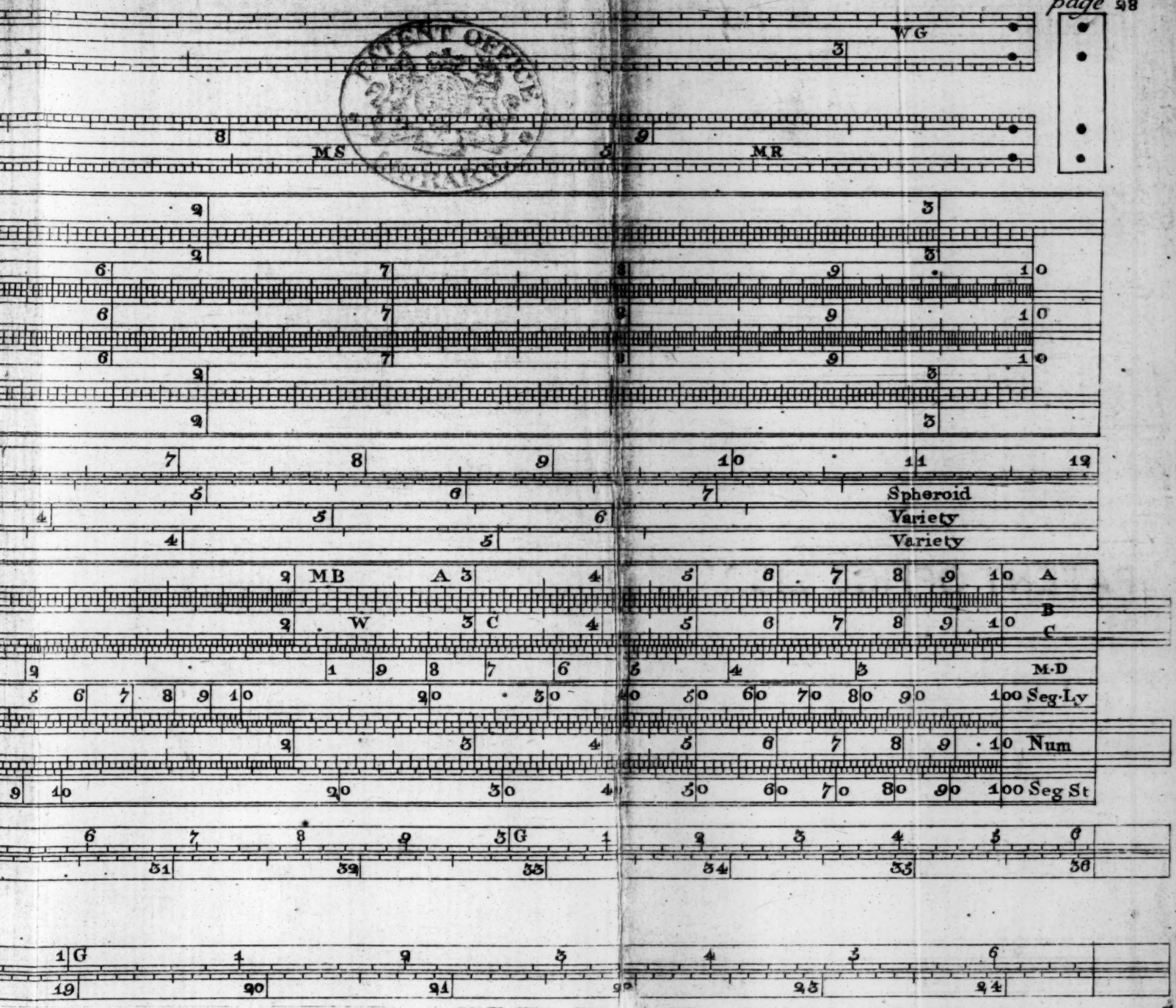
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and the other towards the Left, till the whole be 6 Foot long.

The principal Lines on the Inſtrument are thoſe commonly known by the Name of *Gunter's Line*, or *Line of Numbers*, which are diſtinguiſh'd by certain Letters.

The Lines A and B are each *two* Lines or Radius's of Numbers, broken each into 2 Parts, the firſt Part of the firſt Line beginning at the Top of the Rule on the Left Hand, and proceeding on to the End of the Rule, is continued in the next Line under on the Rule to the End; and the ſecond Radius begins at the Bottom of the Rule on the Left Hand, and proceeding in the ſame manner as the other, is continued in the next Line above to the End.

The Line C on the other Side of the Slides, is a ſingle Line of Numbers broken into 4 Parts; the firſt Part beginning at the Top on the Left Hand of the Upper Slide, and proceeding on to the End, is continued on the Bottom of the ſame Slide from the Left Hand to the Right, from whence it is further continued in like manner on the Bottom of the Lower Slide, and from thence on the Top of the ſame Slide to the End; by which means this ſingle Radius, which is equal in Length to the double Radius, is eight Foot long.

The Line of Numbers is a Line of Geometrical Proportions, beginning at the Fi-

gure 1, and proceeding on to 2, 3, 4, 5, 6, 7, 8, 9, to 10. The Distances between each of these Figures are divided into *ten* Parts, and those Divisions again into *ten* other Parts, and between 1 and 3 on the single Radius, the Divisions last mentioned are subdivided into 5 Parts.

Numeration upon the Lines.

Whatsoever Denomination the 1 at the Beginning of the Line is, That at the End of the first Radius will be *Ten* times, and that at the End of the second Radius will be a *Hundred* times so many; and supposing the first Radius to take Place after the second, (as it often happens in working with this Rule) the 1 at the End thereof will be a Thousand times so many as the 1 at the beginning, when it is the first Radius.

EXAMPLE.

If the Beginning be accounted	The End of the 1st Radius is	The End of the 2d Radius is	The End of the 3d Radius is
.1	.1	1	10
.1	1	10	100
1	10	100	1000
10	100	1000	10000

This being well understood: Suppose it were required to find the Place of 26 on the Line

Line A or B; you may eſteem 1 at the Beginning of the Lines but 1, then will that at the End of the firſt Radius be 10, and the 2 which ſtands on the ſecond Radius will be 20; then count 6 of the grand Diviſions further, for that is the Place of 26. 'Tis plain alſo from what has been ſaid above, that the ſame Place repreſents .026, .26, 2.6, 260, 2600, *&c.*

Suppoſe it were required to find the Place of 456 on the Line A or B; Firſt, eſteem the 1 at the Beginning of the Line to be 10, then will that at the End of the firſt Radius be 100, and the 4 which is on the ſecond Radius 400; from which count 5 of the grand Diviſions, and then count 6 of the leſſer Diviſions, which is the Place of 456. And it is alſo the Place of .0456, .456, 4.56, 45.6, 4560, *&c.*

Let it be required to find the Place of 2638 on the Line C. For your firſt Figure 2, count the Figure 2 which ſtands upon the Line: For the ſecond Figure 6, count 6 of the grand Diviſions; for the third Figure 3, count 3 of the ſmalleſt Diviſions, and for the fourth Figure 8, it is by Eſtimation almoſt another, and that will be the Place of 2638. And it is the Place of .02638, .2638, 2.638, 26.38, 263.8, 26380, *&c.*

Again, To find the Place repreſenting 20045; for the firſt Figure 2, count the Figure 2 which ſtands on the Line; your ſe-

cond and third Figures being 0, count none of the grand Diviſions nor of the ſmalleſt Diviſions; and for the laſt Figures 45, it is by Eſtimation a little further.

Note, In all Operations with the Lines A and B, the lower Slide muſt be taken out, and is only uſeful in continuing the Lines on the firſt Slide.

Multiplication by the Lines.

In Multiplication the Proportion is
As 1 is to the Multiplier,
So is the Multiplicand to the Product.

EXAMPLE. I.

Let it be required to multiply 40 by 12.

Set 1 upon the Line A, to 12 upon B; and againſt 40 upon A, is 480 upon B, which is the Product ſought.

EXAMPLE II.

Let it be required to multiply 51 by 6.

Set 1 upon the Line A, to 6 upon B; then againſt 51 upon A, is 306 upon B, which is the Product ſought.

Note, That in this and all other Caſes where the firſt and ſecond Numbers cannot be ſet together in the upper Part of the Rule, the

the Slide muſt be put in the lower Part, and then the 1 being at the Beginning of the ſecond Radius, the Operation will be the ſame.

Note alſo, That the Product of any two Numbers will have ſo many Places as there be in both the Numbers given, except the Multiplier be leſs than the ſame Number of the firſt Figures in the Product, and then it will have one leſs; ſo in the 2d Example there are 2 Figures in the Multiplicand and one in the Multiplier, and therefore three in the Product. But in the 1ſt Example there are but three Figures in the Product notwithſtanding there are two in the Multiplicand and two in the Multiplier, becauſe 12 the Multiplier is leſs than 48 the ſame Number of the firſt Figures in the Product.

EXAMPLE III.

Let it be required to multiply 29 by 20.

Set 1 upon A, to 20 upon B; then againſt 29 upon A is 580 upon B, the Product required.

EXAMPLE IV.

What is the Product of 837 by 4.2?

Set 1 upon A to 4.2 upon B; then againſt 837 upon A is 3515.4 upon B; the Product required.

It ſometimes happens, as in the laſt Example, that the Product will conſiſt of more Figures than you can find on the Rule; therefore you may in your Mind multiply the Unit Figure of the Multiplier by that of the Multiplicand, as above, multiply 7 by 2, and the Product is 14; by which 'tis plain that the 4 will poſſeſs the Unit's Place of the Product.

Note, That in the two laſt Examples, and all other Caſes, where the firſt Slide does not reach to the third Number, you muſt apply the ſecond Slide thereto, *viz.* join the Beginning of the ſecond Slide to the End of the Firſt, or the End of the ſecond to the Beginning of the firſt Slide, as the Occaſion requires.

EXAMPLE V.

What is the Product of 2.51 by .15?

Set 1 upon A, to .15 upon B; then againſt 2.51 upon A is .3765 upon B, the Product requir'd.

Diviſion by the Lines.

In Diviſion the Proportion is
As the Diviſor is to 1,
So is the Dividend to the Quotient.

EX.

EXAMPLE I.

Divide 75 by 25.

Set 25 upon A, to 1 upon B; then (the Slides being join'd) againſt 75 on A, is 3 upon B, which is the Quotient required.

'Tis eaſy to know how many Figures will be in the Quotient, by comparing the Diviſor and Dividend.

EXAMPLE II.

Divide 82 by 1.8.

Set 1.8 upon A, to 1 upon B; then againſt 82 upon A, is 45.55 upon B, which is the Quotient required.

EXAMPLE III.

Divide 300 by 76.

Set 76 upon A, to 1 upon B; then againſt 300 upon A is 3.947 upon B, which is the Quotient required.

In the laſt and following Examples, the Slide muſt be put in the lower Part of the Rule, that is, againſt the ſecond Radius.

EXAMPLE IV.

Divide 48.5 by 6.4.

Set 6.4 upon A, to 1 upon B; then (the Slides being join'd) againſt 48.5 upon A, is 7.578 upon B, which is the Quotient ſought.

EXAMPLE V.

Divide 195 by 8.

Set 8 upon A, to 1 upon B; then (the Slides being join'd) againſt 195 upon A, is 24.37 upon B, which is the Quotient ſought.

Reduction of Decimals by the Lines.

To reduce a Vulgar Fraction into a Decimal, the Proportion is,

As the Denominator is to the Numerator,
So is 1 to the Decimal.

EXAMPLE I.

Reduce $\frac{2}{3}$ to a Decimal Fraction.

Set 3 upon A, to 2 upon B; then (the Slides being join'd) againſt 1 upon A, is .6666 upon B, which is the Decimal ſought.

EX-

EXAMPLE II.

What Decimal Part of a Barrel is 15 Gallons?

The Vulgar Fraction is $\frac{15}{34}$; therefore ſet 34 upon A, to 15 upon B; then againſt 1 upon A, is .4411 upon B, which is the Decimal ſought.

EXAMPLE III.

What is .378 of a Pound Sterling?

1. Set 1 upon A, to 20 (the Number of Shillings in a Pound) upon B; then againſt .378 upon A, is 7.56 upon B, that is 7 Shillings and .56 of a Shilling.

2. Set 1 upon A, to 12 (the Pence in a Shilling) upon B; then againſt 56 upon A, is 6.72 upon B, that is 6 Pence and .72 of a Penny.

3. Set 1 upon A, to 4 (the Farthings in a Penny) upon B; then againſt 72 upon A, is 2.88 upon B, that is 2 Farthings and .88 of a Farthing.

EXAMPLE IV.

What is .426 of a Barrel of Beer?

1. Set 1 upon A, to 34 (the Gallons in a Barrel) upon B, then againſt .426 upon A, is 14.484 upon B, that is 14 Gallons and .484 of a Gallon.

2. Set

2. Set 1 upon A, to 8 (the Pints in a Gallon) upon B, then againſt .484 is 3.872 upon B, that is 3 Pints and .872 of a Pint; and thus is .426 of a Barrel of Beer found to be 14 Gallons 3 Pints and .872 of a Pint.

The Rule of Three by the Lines.

The Rule of Three by the Lines is wrought thus:

Set the firſt Number given upon A, to the ſecond upon B, and then againſt the third Number upon A, is the fourth Number required on B.

EXAMPLE I.

If the Duty of 26 Barrels of Beer be worth 5 *l.* 14 *s.* or 114 Shillings, what is the Duty of 47.6 Barrels?

Set 26 upon A, to 114 upon B; then againſt 47.6 upon A, is 208.7 upon B; that is, 208 Shillings and .7 of a Shilling, which reduced as before, is 10 *l.* 8 *s.* 8 *d.* $\frac{1}{2}$. the Anſwer.

EXAMPLE II.

If the Duty of 36 Buſhels of Malt be 18 *s.* what is the Duty of 44 Buſhels at that Rate?

Set 36 upon A, to 18 upon B; then againſt 44 upon A, is 22 upon B; that is 22 *s.* the Anſwer.

EX-

EXAMPLE III.

If 6 Quarters of Malt make 14 Barrels of Beer, how many Quarters of Malt will make 26 Barrels of ſuch Beer?

1. Set 14 upon A, to 6 upon B; then againſt 26 upon A, is 11.142 upon B, that is 11 Quarters and .142 of a Quarter.

2. Set 1 upon A, to 8 (the Buſhels in a Quarter) upon B; then againſt .142 upon A, is 1.136 upon B, that is 1 Buſhel and .136 of a Buſhel; thus you have found the Anſwer to be 11 Quarters 1 Buſhel and .136 of a Buſhel.

EXAMPLE IV.

If a Veſſel contain 37 Gallons of Beer, how many Gallons of Wine will it hold?

The Proportion between Beer and Wine is as 282 to 231; therefore

Set 231 upon A, to 282 upon B; then againſt 37 upon A, is 45.168 upon B, that is 45 Gallons and .168 of a Gallon of Wine.

To find the Square Root of any Number.

THE Extraction of Roots is very eaſy, for if the Lines A and C be ſet even, that is ſo as 10 at the End of C be even with 10 at the End of A; then theſe Lines thus applied

applied will be as a Table of Squares and their Roots, for againſt any Square on the Line A, you will have its Root upon C.

Note, When the Figures in the given Number are even, *viz.* when the Number conſiſts of 2, 4 or 6 Figures, (being Integers) look the ſame in the ſecond Radius of the Line A, and againſt it you will have the Square Root upon C.

EXAMPLE I.

What is the Root of 2304?

Having ſet the Lines A and C even, find 2304 in the ſecond Radius of the Line A, and againſt it upon C you will find 48 the Square Root ſought.

In like manner { 8 / 35 / 834 } is the Root of { 64 / 1225 / 695556 }

When the Integers in the given Number are odd, *viz.* 1, 3 or 5, ſeek it upon the firſt Radius of the Line A, and againſt it you will have the Root required upon C.

EXAMPLE II.

What is the Root of 625?

Find 625 upon the firſt Radius of the Line A, and againſt it on C you will have 25, the Root ſought.

In

In like manner { 2.8 / 30 / 135 } is the Root of { 7.84 / 900 / 18225 }

Before you uſe the Sliding-Rule, point your Number given, as before directed, and your Root will have as many Figures as there be Points.

To find a Mean Proportional between any two Numbers given.

SET either of the two Numbers given upon A, to the ſame upon C; then againſt the other given Number upon A, is the Mean required upon C.

Note, In all Proportions that are performed with the Lines A and C, both the Slides are uſed, and always moved alike, by means of a ſmall Piece of Braſs to draw them both out at once the ſame way.

EXAMPLE I.

What is the Mean Proportional between 64 and 256?

Set 64 upon A, to 64 upon C; then againſt 256 upon A, is 128 (the Mean required) upon C.

Note, That if the firſt and ſecond given Numbers cannot be ſet together as the Slides are

are in their proper Order, you must change their Places, by putting the 1st Slide against the 2d Radius on the Rule, and the 2d Slide against the first Radius on the Rule, and then proceed in all respects as in the other Case.

EXAMPLE II.

What is the Mean Proportional between 40 and 62.5?

Set 40 upon A, to 40 upon C; then against 62.5 upon A is 50 (the Mean required) upon C.

EXAMPLE III.

What is the Mean Proportional between 20 and 320?

Set 20 upon A, to 20 upon C; then against 320 upon A, is 80 (the Mean required) upon C.

Where Note, That in this and many other like Questions you must join the Slides, after they are both drawn out alike, and the first Number set to the second.

The Uſe of the RULE *in Meaſuring Boards, Timber, Stone,* &c.

PROB. I.

The Breadth of a Board being given in Inches and the Length in Feet, to find the Content in Feet.

Rule { Set 12 upon A, to the Breadth of the Board in Inches on B, then againſt the Length (in Feet) of the Board on A, will be the Content in Feet on B.

EXAMPLE.

Suppoſe the Breadth of a Board be 15 Inches, and the Length 17 Feet, what is the Content in Feet?

Set 12 on A, to 15 on B; then againſt 17 on A, is 21.25 on B; that is, 21 Foot and one Quarter of a Foot, which is the Area required.

PROB.

Prob. II.

The Side of the Square of a Piece of Timber or Stone being given in Inches, and the Length in Feet, to find the Content in Feet.

Rule { Set 12 upon C, to the Length in Feet upon A, then againſt the Side of the Square in Inches upon C, will be the Content in Feet upon A.

EXAMPLE.

Suppoſe a Piece of Timber or Stone be 16 Inches Square, and 15 Foot Long, what is the Content in Solid Feet?

Set 12 on C, to 15 on A, then againſt 16 on C, is 26.652 on A; that is, 26 Foot and .652 of a Foot, which is the Content required.

If the Timber be unequal ſided, you muſt find a Mean Proportional betwixt the Breadth and Depth, and that is the Side of a Square Piece of Timber equal thereto; therefore ſet 12 on C, to the Length on A; and againſt the Mean Proportional on C will be the Content on A; as in the laſt Example.

PROB. III.

The Circumference of a Round Tree being given in Inches, and the Length in Feet, to find the Content in Feet.

Rule { Set 42.53 (a fixed Number for this Purpoſe) on C, to the Length in Feet on A; then againſt the Circumference on C, will be the Content in Feet on A.

EXAMPLE.

Suppoſe a Piece of Timber or Stone be 63 Inches Girth or Circumference, and 22 Foot Long, what is the Content in ſolid Feet?

Set 42.53 on C, to 22 on A, then againſt 63 on C is 48.24 on A; that is 48 Foot and 24 of a Foot, which is the Content required.

GAUG-

GAUGING

PERFORM'D

ARITHMETICALLY

AND

INSTRUMENTALLY.

IT is neceſſary that the young Gauger be well acquainted with the following *Definitions*, and that he ſhould underſtand not only how to take Dimenſions, (which is beſt learn'd by Practice) but alſo how to divide any *Irregular Figure*, or Superficies, as Brewers Backs or Coolers, *&c.* into the eaſieſt and feweſt *Regular Figures* they will admit of, that ſo their Area's may be computed with the leaſt Trouble.

DEFINITIONS.

1. A Point hath no Parts, being only an aſſignable Place in any Quantity.

2. A Line is that which hath Length but no Breadth, and is produced by the Motion of a Point.

3. A Superficies or Surface is that which has both Length and Breadth, and is produced by the Motion of a Line.

Note, The Superficies of any Figure is uſually called its Area.

4. A Solid admits of Length, Breadth and Thickneſs.

5. Parallel Lines are thoſe that lie equally diſtant one from another in all their Parts.

6. Lines not parallel by inclining, *viz.* leaning one towards another, will meet and make an Angle, and according as thoſe Lines are nearer or ſtand further off each other, that Angle is ſaid to be leſſer or greater.

7. When a Line falling on another Line, maketh the Angle on each Side thereof equal: Thoſe Angles are Right Angles, and the Line ſo falling is a Perpendicular.

8. An obtuſe Angle is that which is greater than a Right Angle.

9. An Acute Angle is that which is leſs than a Right Angle.

Note, That all Dimenſions uſeful in Gauging, are to be taken in Inches and Decimal Parts of an Inch, becauſe the Contents of all ſorts of Veſſels (in Gauging) are computed

puted by the Standard Gallon of its Kind, whoſe Content is known to be a certain Number of Cubick Inches; that is, the Beer and Ale Gallon contains 282, the Wine Gallon 231, and the Corn Gallon 268.8 Cubick Inches, therefore the Corn Buſhel is 2150.4 Cubick Inches, (Mr. *Everard* ſays that 2150 is near enough) for a Diviſor for all Right-lined Figures.

In Gauging, all Superficies or Area's are always underſtood to be one Inch deep.

To Gauge a Square.

DEFINITION.

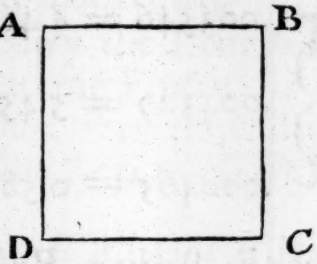
A Square has four equal Sides, and four Right Angles.

Rule { Multiply the given Side into itſelf, and the Product will be the Area in Inches, which divide by 282 for Ale Gallons, 231 for Wine, and 2150 for Malt Buſhels.

EX-

EXAMPLE.

Suppoſe the Side AB of the Square ABCD be 35.5 Inches, what is the Area in Ale and Wine Gallons and Malt Buſhels?



Firſt, 35.5 multiplied by 35.5 is 1260.25, the Area in Inches; then

282) 1260.250 (4.468 Area in Ale Gallons.

231) 1260.250 (5.455 Area in Wine Gallons.

2150) 1260.250 (.586 Area in Malt Buſhels.

This Diviſor may be turned into a Multiplier, if you divide Unity or 1. by the Diviſor, thus,

282) 1.000000 (.003546 the Multiplier for Ale Gallons.

231) 1.000000 (.004329 the Multiplier for Wine Gallons.

2150) 1.000000 (.00465 the Multiplier for Malt Buſhels.

Therefore

1260.25 × { .003546 = 4.468 Gallons.
.004329 = 5.455 Gallons.
.000465 = 0.586 Buſhels.

By the Sliding-Rule.

For Ale.

Set 282 upon A, to 35.5 upon B; then againſt 35.5 upon A is 4.468 upon B, the Area in Ale Gallons.

For Wine.

Set 231 upon A, to 35.5 upon B; then againſt 35.5 upon A is 5.455 upon B, the Area in Wine Gallons.

For Malt.

Set 2150 upon A, to 35.5 upon B; then againſt 35.5 upon A is .586 on B, the Area in Malt Buſhels.

To Gauge a Rectangle.

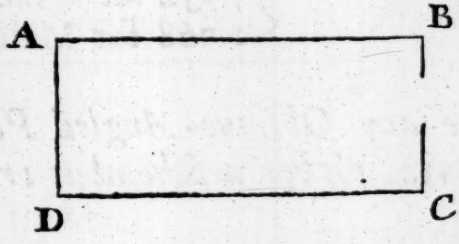
DEFINITION.

A Rectangle or Right-Angled Parallelogram hath four Right Angles, and its two oppoſite Sides equal.

Rule { Multiply the Length by the Breadth, and the Product is the Area in Inches, then either divide or multiply that Area as above.

EXAMPLE.

Let ABCD be a Rectangle whoſe Length AB or CD is 56.2 Inches, and its Breadth AD or BC 29.4 Inches: What is the Area in Ale and Wine Gallons, and Malt Buſhels?



Firſt, 56.2 multiplied by 29.4, is 1652.28, the Area in Inches.

282) 1652.280 (5.859 Area in Ale Gallons.

231) 1652.280 (7.152 Area in Wine Gallons.

2150) 1652.280 (0.768 Area in Malt Buſhels.

Or, 1652 28 × { .003546 = 5.8589 Gallons. / .004329 = 7 152 Gallons. / .000465 = 0.768 Buſhels.

By the Sliding-Rule.

Set { 282 for Ale / 231 for Wine / 2150 for Malt } on A, to 29.4 on B;

then againſt 56.2 on A, is { 5.859 for Ale / 7.152 for Wine / 0.768 for Malt } on B.

To Gauge any Oblique-Angled Parallelogram, viz. *either a Rhombus or Rhomboides.*

DEFINITION.

1. A Rhombus hath four Equal Sides but no Right Angle.

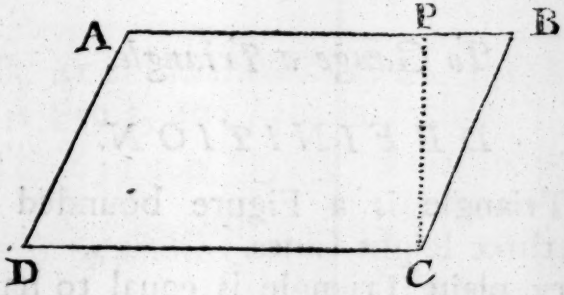
2. A Rhomboides hath its two oppoſite Sides equal but no Right Angle.

Rule

Rule { Multiply the Length into its Perpendicular Height (or Breadth) and the Product is the Area in Inches, then divide (or multiply) that Area as above.

EXAMPLE.

Suppoſe A B C D be a Rhomboides whoſe Side A B is 89 Inches, and C P = 54 Inches, (being the neareſt Diſtance between the two Sides A B and C D) I demand the Area in Ale and Wine Gallons, and Malt Buſhels?



Firſt, 89 multiplied by 54, is 4806, the Area in Inches.

282) 4806.000 (17.042 Area in Ale Gallons.

231) 4806.000 (20.805 Area in Wine Gallons.

2150) 4806.000 (2.235 Area in Malt Buſhels.

Or, 4806 × { .003546 = 17.042 Gallons. / .004329 = 20.805 Gallons. / .000465 = 2 234 Buſhels.

By the Sliding-Rule.

Set { 282 for Ale / 231 for Wine / 2150 for Malt } on A, to 89 upon B;

then againſt 54 on A, is { 17.042 for Ale / 20.805 for Wine / 2.235 for Malt } on B.

To Gauge a Triangle.

DEFINITION.

A Triangle is a Figure bounded with three Right Lines.

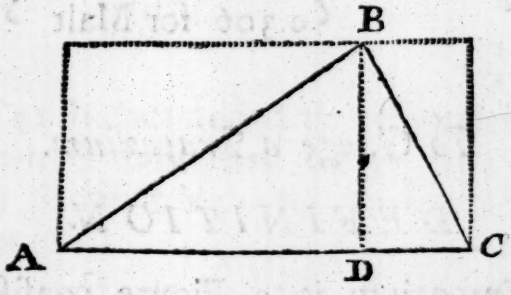
Every plain Triangle is equal to half its circumſcribing Parallelogram (41. e. 1) whence the following Rule.

Rule { Multiply the Baſe (A C) by half the Perpendicular (B D) and the Product is the Area in Inches, which divide (or multiply) as above.

EX-

EXAMPLE.

Suppoſe A B C be a Triangle whoſe Baſe A C is 41.2 Inches, and Perpendicular B D is 32 Inches; I demand the Area in Ale and Wine Gallons, and Malt Buſhels?



Firſt, 41.2 multiplied by 16 (the half of B D) is 659.2, the Area in Inches.

282) 659.200 (2.337 Area in Ale Gallons.

231) 659.200 (2.853 Area in Wine Gallons.

2150) 659.200 (0.306 Area in Malt Buſhels.

Or, 659.2 × { .003546 = 2.337 Gallons. / .004329 = 2.853 Gallons. / .000465 = 0.306 Buſhels.

By the Sliding-Rule.

Set { 282 for Ale / 231 for Wine / 2150 for Malt } on A, to 41.2 on B;

then againſt 16 on A, is { 2.337 for Ale / 2.853 for Wine / 0.306 for Malt } on B.

To Gauge a Trapezium.

DEFINITION.

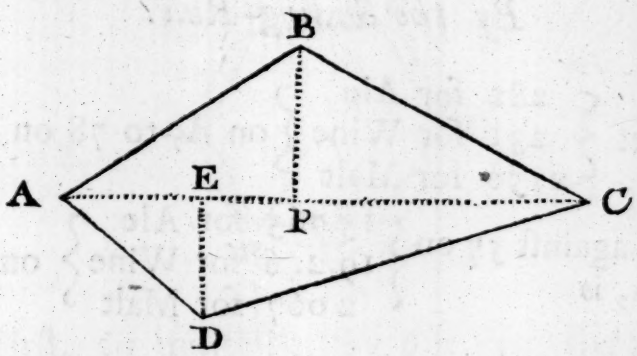
A Trapezium is a Figure conſiſting of four unequal Sides.

Rule { Add the two Perpendiculars together, and multiply that Sum by half the Diagonal, and the Product is the Area in Inches, which divide (or multiply) as above.

EXAMPLE.

Suppoſe A B C D be a Trapezium, whoſe Diagonal A C, is 114 Inches, the Perpendicular B P, 41 Inches, and the Perpendicular D E 37 Inches; I demand the Area in Ale and Wine Gallons, and Malt Buſhels?

First,



First, 41 Inches added to 37 Inches, is 78 Inches, which multiplied by 57 (the half of 114) the Product is 4446, which is the Area in Inches.

282) 4446.000 (15.765 Area in Ale Gallons.

231) 4446.000 (19.246 Area in Wine Gallons.

2150) 4446.000 (2.067 Area in Malt Buſhels.

Or, 4446 × { .003546 = 15.765 Gallons. / .004329 = 19.246 Gallons. / .000465 = 2.067 Buſhels.

By the Sliding-Rule.

Set { 282 for Ale / 231 for Wine / 2150 for Malt } on A, to 78 on B;

then againſt 57 on A, is { 15.765 for Ale / 19.246 for Wine / 2.067 for Malt } on B.

To Gauge a Regular Polygon.

DEFINITION.

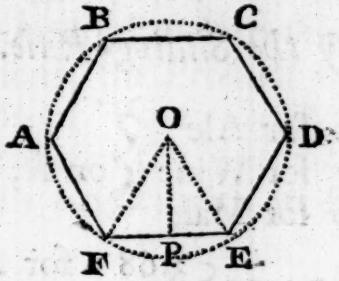
A Regular Polygon is a Figure which hath all its Sides equal, ſtanding at equal Angles; and of ſuch Figures, that of five equal Sides is called a Pentagon; that of ſix equal Sides is called a Hexagon; that of ſeven equal Sides is called a Heptagon, *&c.*

Rule { Multiply half the Sum of the Sides by the neareſt Diſtance of any Side from the Centre, and then divide (or multiply) as above.

EXAMPLE.

Suppoſe ABCDEF be a Hexagon whoſe Sides are each 20 Inches, and the Perpendicular OP is 17.3 Inches; what is the Area in Ale and Wine Gallons, and Malt Buſhels?

Firſt,



First, 20 multiplied by 6 is 120, the Sum of the Sides, the half of 120 is 60, which multiplied by 17.3 is 1038, the Area in Inches.

282) 1038.000 (3.68 Area in Ale Gallons.

231) 1038.000 (4.493 Area in Wine Gallons.

2150) 1038.000 (0.482 Area in Malt Buſhels.

Or, 1038 × { .003546 = 3.68 Gallons. / .004329 = 4.493 Gallons. / .000465 = 0.482 Buſhels.

By the Sliding-Rule.

Set { 282 for Ale / 231 for Wine / 2150 for Malt } on A, to 60 on B;

then againſt 17.3 on A, is { 3.68 for Ale / 4.493 for Wine / 0.482 for Malt } on B.

Having found the true Area of any Brewer's Back or Cooler, to find the true Dipping or Gauging-place in that Back.

1. WHEN the Bottom of the Back is cover'd all over (of any Depth) with Liquor, then dip it in eight or ten ſeveral Places, as remote and equally diſtant one from another as you well can, noting down the wet Inches and Decimal Parts of every Dip.

2. Divide the Sum of all thoſe Dips or wet Inches by the Number of Places you dipp'd in, and the Quotient will be the *mean Wet* of all thoſe Dips.

3. Find out ſuch a Place by the Side of the Back that juſt wets the ſame with that *mean Dip*, and make a Mark there for the true and conſtant Dipping-place of that Back. Then if any Quantity of Worts which do cover the whole Back be dipp'd

or

or gauged at that Place, and the *wet Inches* ſo taken be multiplied into the Area of the Back in Gallons, the Product will ſhew how many Gallons of Worts are in that Back at that time, provided the Sides of the Back do ſtand at Right Angles with its Bottom.

To Gauge a Circle.

DEFINITION.

A Circle is a plain Figure, whoſe Area is bounded or limited by one continued Line, called the Circumference or Periphery of the Circle, and is every where equally remote from the middle Point or Centre.

The Diameter of a Circle is a Line drawn through the Centre ending at the Periphery on each Side, and divides the Circle into two equal Parts.

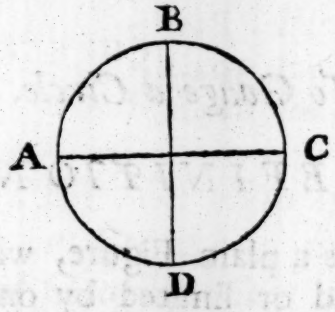
Rule { Divide the Square of the Diameter of any Circle by 359 for Ale Gallons, 294 for Wine, and 2737.47 for Malt Buſhels.

Or, { Multiply the Square of the Diameter of any Circle by .002785 for Ale Gallons, by .0034 for Wine, and by .000365 for Malt Buſhels.

EX-

EXAMPLE.

Suppoſe A B C D be a Circle whoſe Diameter A C is 36 Inches, what is the Area in Ale and Wine Gallons, and Malt Buſhels?



Firſt, 36 (the Diameter) being ſquared, is 1296, then

359) 1296.000 (3.61 Area in Ale Gallons.

294) 1296.000 (4.408 Area in Wine Gallons.

2737.47) 1296.00000 (0.473 Area in Malt Buſhels.

Or, 1296 × { .002785 = 3.609 Gallons. / .0034 = 4.406 Gallons. / .000365 = 0.473 Buſhels.

By

By the Sliding-Rule.

Set { 359 for Ale, 294 for Wine, 2737.47 for Malt } on A, to 36 on B;

then againſt 36 on A, is { 3.61 for Ale, 4.408 for Wine, 0.473 for Malt } on B.

The Diviſors above are found thus.

The Content of a Circle whoſe Diameter is 1, is .785398, and Circles are as the Squares of their Diameters (2 *Eucl.* 12.) therefore,

As .785398 : 1 :: 282 : 359, the Square of the Diameter of that Circle whoſe Area is 282 Cubick Inches, or one Ale Gallon.

So likewiſe as .785398 : 1 :: 231 : 294, which is the Diviſor for Wine Gallons.

And as .785398 : 1 :: 2150 : 2737.47, which is the Diviſor for Malt Buſhels.

The Diviſors above are turned into Multipliers, by dividing 0.785348 (the Area in Inches of that Circle whoſe Diameter is 1 Inch) by 282, 231, and 2150. Thus,

Multipliers

282) 0.785348 (.002785 for Ale.
231) 0.785348 (.003399 for Wine.
2150) 0.785348 (.000365 for Malt.

Mr.

Mr. *Everard* ſays, the Area of any Circle may be more readily found (by the Sliding-Rule) by the Help of certain fix'd Numbers, called Gauge Points, and theſe fix'd Numbers are the Diameters of thoſe Circles whoſe Content at one Inch deep is equal to the reſpective Gallons or Buſhels to which they belong; thus the Gauge Point for the Ale Gallon is 18.94, which is the Diameter of that Circle whoſe Content is 282, the Square Inches in the Ale Gallon.

Theſe Gauge Points are the Square Roots of the Diviſors laſt mention'd, and are all found at once by the Rule, by ſetting the Lines A and C even at the End.

Againſt	359	are theſe	18.94
theſe Divi-	294	Gauge Points	17.15
ſors upon A,	2737.47	upon C,	52.32

To find the Area of a Circle by the Gauge Points upon the Sliding-Rule.

Rule { Set the Gauge Point upon C to 1 upon A, then againſt any Diameter upon C is the Area upon A.

Suppoſe (as in the laſt Example) the Diameter were 36 Inches, what is the Area in Ale and Wine Gallons, and Malt Buſhels?

Set

Set { 18.94 for Ale / 17.15 for Wine / 52 32 for Malt } on C, to 1 on A;

hen againſt 36 on C, is { 3.61 for Ale / 4.408 for Wine / 0.473 for Malt } on A.

The Rule being thus ſet, the Lines are ike a Table of Circles Areas, for

If the Diameter be { 45 / 50 / 52.5 } The Area will be { 5.64 / 6.96 / 7.67 } Ale Gallons.

To Gauge a Sector of a Circle.

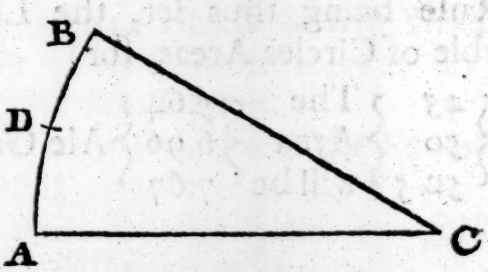
DEFINITION.

A Sector of a Circle is a Figure included between two Radius's or Semidiameters f the Circle, having any Part of the Cir- umference for its Baſe.

ule { Multiply the Radius or Semidiameter by half the Arch of the Sector, and divide the Product by 282 for Ale Gallons, 231 for Wine, and 2150 for Malt Buſhels; or multiply by .003546 for Ale, *&c.*

EXAMPLE.

Suppoſe A D B C be a Sector of a Circle whoſe Radius A C = B C is 36 Inches, and A B is 24 Inches; What is the Area in Ale and Wine Gallons, and Malt Buſhels?



Firſt, The Radius A C = 36 Inches multiplied by A D (the half of A B) = 12 Inches, is 432 Inches, which is the Area in Inches; then

282) 432.000 (1.531 Area in Ale Gallons.

231) 432.000 (1.87 Area in Wine Gallons.

2150) 432.000 (0.2 Area in Malt Buſhels.

Or, 432 { .003546 = 1.531 Gallons.
.004329 = 1.87 Gallons.
.000465 = 0.2 Buſhels.

By the Sliding-Rule.

Set { 282 for Ale / 231 for Wine / 2150 for Malt } on A, to 36 on B;

hen againſt 12 on A, is { 1.531 for Ale / 1.87 for Wine / 0.2 for Malt } on B.

To Gauge a Segment of a Circle.

DEFINITION.

A Segment of a Circle is a Figure included betwixt the Chord (D E) and that Arch f the Periphery which is cut off by the hord.

The Area of any Segment may be readily ound in Gallons without finding its Area in nches, by help of the following Table of egments.

A TABLE

A TABLE *of the Segments of a Circle.*

v.s	Area	v.s	Area	v.s	Area	v.s	Area
1	.0017	26	.2066	51	.5127	76	.815
2	.0048	27	.2178	52	.5255	77	.826
3	.0087	28	.2292	53	.5382	78	.836
4	.0134	29	.2407	54	.5509	79	.847
5	.0187	30	.2523	55	.5636	80	.857
6	.0245	31	.2640	56	.5762	81	.867
7	.0308	32	.2759	57	.5888	82	.877
8	.0375	33	.2878	58	.6014	83	.887
9	.0446	34	.2998	59	.6140	84	.896
10	.0520	35	.3119	60	.6265	85	.905
11	.0598	36	.3241	61	.6389	86	.914
12	.0680	37	.3364	62	.6513	87	.923
13	.0764	38	.3487	63	.6636	88	.932
14	.0851	39	.3611	64	.6759	89	.940
15	.0941	40	.3735	65	.6881	90	.948
16	.1033	41	.3860	66	.7002	91	.955
17	.1127	42	.3986	67	.7122	92	.962
18	.1224	43	.4112	68	.7241	93	.969
19	.1323	44	.4238	69	.7360	94	.975
20	.1424	45	.4364	70	.7477	95	.981
21	.1526	46	.4491	71	.7593	96	.986
22	.1631	47	.4618	72	.7708	97	.991
23	.1737	48	.4745	73	.7822	98	.995
24	.1845	49	.4873	74	.7934	99	.998
25	.1955	50	.5000	75	.8045	100	1.000

The Use of the Table of Segments.

HAving the Diameter of any Circle, and the Height of any Segment of that rcle given, to find the Verſed Sine, ſay by e Rule of Three,

As the Diameter of the Circle
Is to 100, (the Diameter of the Tabular Circle)
So is the Height of the Segment
To a Verſed Sine in the Table.

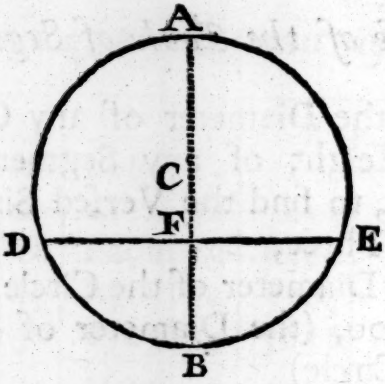
Then multiply the *Segment* which ſtands ainſt that Verſed Sine in the Table by the rcle's Area, the Product will be the Area the Segment required.

Note, If the Circles Area be Inches, the gment will be Inches: If Gallons, the Segent will be Gallons, *&c.*

EXAMPLE.

Suppoſe the Diameter of the given Circle AB = 60 Inches, and the Height of the gment be FB = 24 Inches; What is the ea in Ale and Wine Gallons, and Malt ſhels?

First,



First, The Area of the whole Circle will be { 10.027 Ale Gallons. 12.244 Wine Gallons. 1.315 Malt Bushels.

and the Proportion will be,

As 60 : 100 :: 24 : 40, the Versed Si in the Table, whose Segment is .3735, the

Area of the Segment.

.3735 × { 10.027 = 3.745 Gallons of Ale. 12.244 = 4.573 Gallons of Wi 1.315 = 0.491 Bushels of Mal

To Gauge an Oval.

DEFINITION.

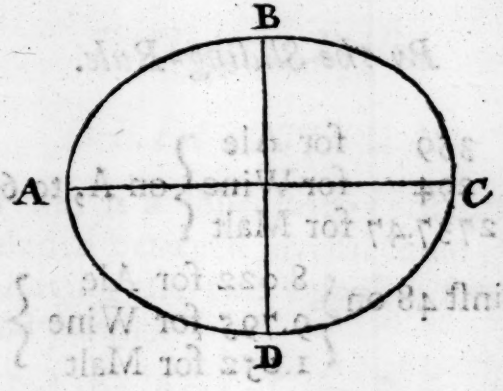
AN Oval or Ellipsis is a Circular Figu as ABCD, having two unequal D meters, as AC which is called the Tra verse, and BD the Conjugate Diameter.

R

Rule { Multiply the Tranſverſe Diameter by the Conjugate Diameter, then divide the Product by 359 for Ale Gallons, 294 for Wine, and 2737.47 for Malt Buſhels; or multiply by .002785 for Ale, *&c.*

EXAMPLE.

Suppoſe A B C D be an Oval, or Ellipſis, whoſe Tranſverſe Diameter A C is 60 Inches, and the Conjugate Diameter B D is 48 Inches; What is the Area in Beer and Wine Gallons, and Malt Buſhels?



First,

First, Multiply 60 (the Tranſverſe Diameter) by 48 (the Conjugate Diameter) and the Product is 2880, then

359) 2880.000 (8.022 Area in Ale Gallons.

294) 2880.000 (9.795 Area in Wine Gallons.

2737.47) 2880.0000 (1.052 Area in Malt Buſhels.

Or, 2880 × { .002785 = 8.02 Gallons. / .0034 = 9.792 Gallons. / .000365 = 1.051 Buſhels. }

By the Sliding-Rule.

Set { 359 for Ale / 294 for Wine / 2737.47 for Malt } on A, to 60 on B;

then againſt 48 on A, is { 8.022 for Ale / 9.795 for Wine / 1.052 for Malt } on B.

Note, The Area of all Tuns whoſe Sides are ſtraight, and whoſe Baſes being equal, are any of the precedent Figures, are found by multiplying the Area of the Baſes (found as before directed) by the Depth.

To

To find the Quantity of Worts in ſuch ſmall open Veſſels or Tubs whoſe Baſes are either a Circle or an Ellipſis, and have but low Sides, and wider at the Top than the Bottom; you muſt, when the Tub is dry, find the Area of its Bottom, (as above) then, when any of thoſe Tubs have Worts in 'em, take the Diameter of the Surface or Top of the Worts, and find that Area, adding it and the Bottom Area together, and multiply half that Sum by the Depth (taken as near the Middle as you can) the Product is the Quantity of thoſe Worts very near the Truth.

To Gauge a Priſm.

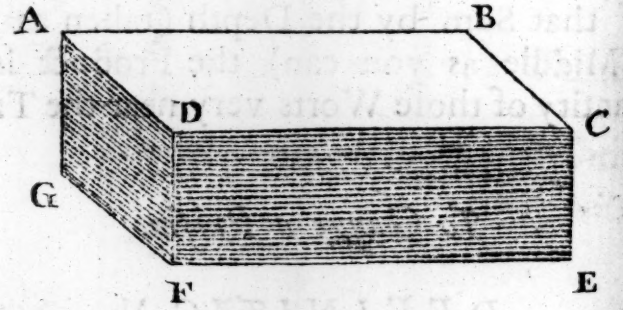
DEFINITION.

A Priſm is a ſolid Body contained or included between ſeveral equal Parallelograms, having the two oppoſite Ends equal, alike, and parallel.

Rule { Find the Area of the Baſe or End as before, then multiply that Area by the Depth, and divide the Product by 282 for Ale Gallons, 231 for Wine, and 2150 for Malt Buſhels, or multiply as before.

EXAMPLE I.

Suppoſe A B C D E F G be a Square Priſm, that is, whoſe Baſe = A B C D is a Square, the Side A B = B C is 122 Inches, and the Depth A G = 26 Inches, What is the Content in Ale and Wine Gallons, and Malt Buſhels?



Firſt, Multiply 122 by itſelf, and the Product is 14884, which multiply by 26 Inches (the Depth) and the laſt Product is 386984 the Content in Inches, then

282) 386984.000 (1372.2 Content in Ale Gallons.

231) 386984.000 (1675.2 Content in Wine Gallons.

2150) 386984.000 (179.9 Content in Malt Buſhels.

Or, 386984 × { .003546 = 1372.2 Gallons. / .004329 = 1675.2 Gallons. / .000465 = 179.9 Buſhels.

By the Sliding-Rule.

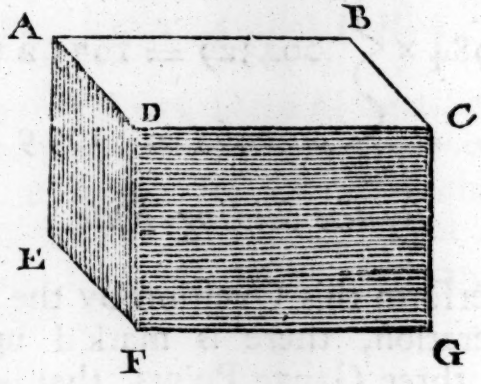
To perform this Queſtion by the Rule at one Operation, there is mark'd upon the Line C, three Gauge Points, that is, one at 16.79, the Square Root of 282 for Ale Gallons; one at 15.19, the Square Root of 231 for Wine; and one at 46.36, the Square Root of 2150 for Malt Buſhels; and their Uſe is as below.

Set { 16.79 for Ale / 15.19 for Wine / 46.36 for Malt } on C, to 26 on A;

then againſt 122 on C, is { 1372.2 for Ale / 1675.2 for Wine / 179.9 for Malt } on A.

EXAMPLE II.

Suppoſe ABCDEFG be a Priſm whoſe Length AB is 42 Inches, the Breadth BC = 34 Inches, and Depth CG = 39 Inches; What is the Content in Ale and Wine Gallons, and Malt Buſhels?



First, Multiply 42 (the Length) by 34 (the Breadth) and the Product is 1428, which multiply by 39 (the Depth) and that Product is 55692, which is the Content in Inches; then,

282) 55692.000 (197.48 Content in Ale Gallons.

231) 55692.000 (241.09 Content in Wine Gallons.

2150) 55692.000 (25.9 Content in Malt Buſhels.

Or, 55692 { .003546 = 197.48 Gallons. .004329 = 241.09 Gallons. .000465 = 25.89 Buſhels.

By

By the Sliding-Rule.

First, Find a Mean Proportional between the Length A B = 42, and the Breadth B C = 34, as before directed, which you will find to be 37.788; then

Set { 16.79 for Ale, 15.19 for Wine, 46.36 for Malt } on C, to 39 on A;

then againſt 37.788 on C, is { 197.48 for Ale, 241.09 for Wine, 25.9 for Malt } on A.

Note, In this Queſtion the Places of the Slides muſt be changed, and they afterwards drawn out together, as in other Caſes, and then the third Number being on that Part of the Slide which is off the Rule, you muſt take the upper Slide out and join it to the other as it then ſtood.

By the Sliding-Rule another way.

Set { 282 for Ale / 231 for Wine / 2150 for Malt } on A, to 42 on B;

then againſt 34 on A, is { 5.063 / 6.181 / .664 } on B.

which is the Area at one Inch deep, this multiplied by 39 (the whole Depth) gives

{ 197.457 for Ale / 241.059 for Wine / 25.896 for Malt } the whole Content.

To Gauge a Pyramid.

DEFINITION.

A Pyramid is a ſolid Figure whoſe Sides are plain Triangles ſet upon any Polygonous Baſe and meeting in a Point.

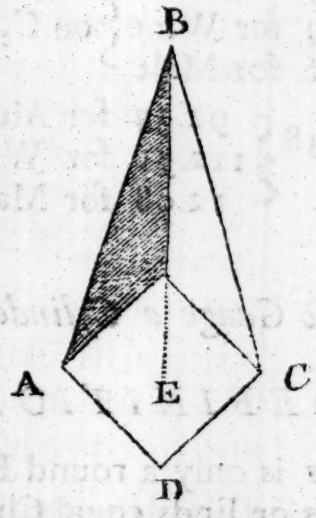
Every Pyramid is one third Part of a Priſm of the ſame Baſe, and of the ſame Height, (7 *Eucl.* 12.) whence this Rule.

Rule { Multiply the Area of the Baſe by one third Part of the Height, and divide that Product by 282 for Ale, 231 for Wine, and 2150 for Malt; or multiply as before.

EX-

EXAMPLE.

Suppoſe A B C D be a Square Pyramid the Side of whoſe Baſe is A D = D C = 38 Inches, and Height B E = 54 Inches; What is the Content in Ale and Wine Gallons, and Malt Buſhels.



Firſt, Multiply 38 by itſelf, and the Product is 1444, which multiplied by 18 ($\frac{1}{3}$ of the Height) the Product is 25992, the Content of the Pyramid in Inches. Then,

282) 25992.000 (92.17 Content in Ale Gallons.

231) 25992.000 (112.519 Content in Wine Gallons.

2150) 25992.000 (12.089 Content in Malt Buſhels.

Or, 25992 × { .003546 = 92.167 Gallons. / .004329 = 112.519 Gallons. / .000465 = 12.086 Bushels.

By the Sliding-Rule.

Set { 16.79 for Ale / 15.19 for Wine / 46.36 for Malt } on C, to 18 on A;

then against 38 on C, is { 92.17 for Ale / 112.51 for Wine / 12.08 for Malt } on A.

To Gauge a Cylinder.

DEFINITION.

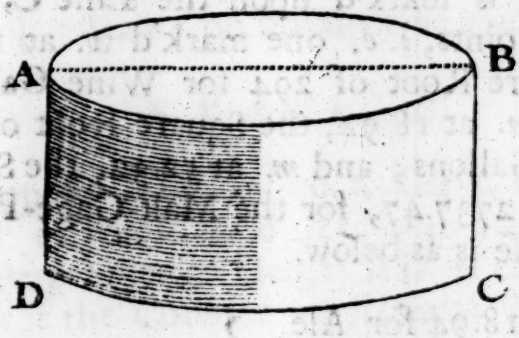
A Cylinder is only a round Prism, having its Bases or Ends equal Circles.

Rule { Multiply the Square of the Diameter by the Depth, and divide the Product by 359 for Ale Gallons, 294 for Wine, and 2737.47 for Malt Bushels; or multiply by .002785 for Ale, *&c.*

EX-

EXAMPLE.

Suppoſe ABCD be a Cylinder whoſe Diameter AB is 54 Inches, and the Depth AD is 24 Inches; What is the Content in Beer and Wine Gallons, and Malt Buſhels?



Firſt, 54 (the Diameter) being ſquared, is 2916, and that multiplied by 24 the Depth, the Product is 69984. Then,

359) 69984.00 (194 94 Content in Ale Gallons.

294.) 69984.00 (238.04 Cont. in Wine Gallons.

2737.47) 69984.0000 (25.56 Cont. in Malt Buſhels.

Or, 69984 × { .002785 = 194.905 Gallons. / .0034 = 237.945 Gallons. / .000365 = 25.544 Buſhels.

Note, If the Baſes are Ellipſis's, you muſt multiply the Tranſverſe by the Conjugate Diameter, and that Product by the Depth, and then divide, or multiply as above.

By the Sliding-Rule.

There is mark'd upon the Line C, three Gauge-Points, *i. e.* one mark'd *w.* at 17.14, the Square Root of 294 for Wine Gallons; another *a.* at 18.94, the Square Root of 359 for Ale Gallons; and *m.* at 52.32, the Square Root of 2737.47, for the Malt-Gage-Point: Their Uſe is as below.

Set { 18.94 for Ale / 17.14 for Wine / 52.32 for Malt } on C, to 24 on A;

then againſt 54 on C, is { 194.94 for Ale / 238.04 for Wine / 25.56 for Malt } on A.

To Gauge a Cone.

DEFINITION.

A Cone is only a round Pyramid whoſe Baſe is a Circle or Ellipſis, and the other End a Point, the intermediate Parts decreaſing thereto.

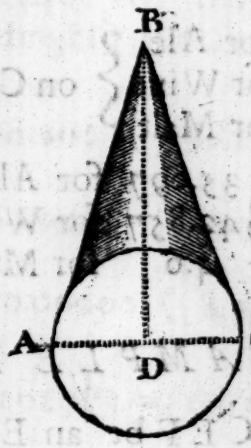
Every

Every Cone is one third Part of its circumscribing Cylinder (10 *Eucl.* 12.) Whence this Rule:

Rule { Multiply the Square of the Diameter of its Base by one third Part of the Perpendicular Height, then divide that Product by 359 for Ale, 294 for Wine, and 2737.47 for Malt; or multiply as before.

EXAMPLE.

Suppose ABCD be a Cone, the Diameter of whose Base AC is 30 Inches, and the Perpendicular Height BD is 42 Inches; What is the Content in Ale and Wine Gallons, and Malt Bushels?



First, Square 30 (the Diameter) which makes 900, and that multiplied by 14 (a third Part of the Height) the Product is 12600. Then,

359) 12600.000 (35.097 Content in Ale Gallons.

294) 12600.000 (42.857 Content in Wine Gallons.

2737.47) 12600.000 (4.6 Content in Malt Buſhels.

Or, 12600 × { .002785 = 35.091 Gallons. / .0034 = 42.84 Gallons. / .000365 = 4.599 Buſhels.

By the Sliding-Rule.

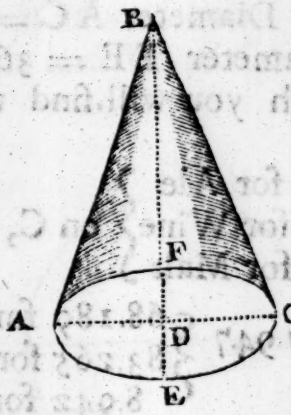
Set { 18.94 for Ale / 17.14 for Wine / 52.32 for Malt } on C, to 14 on A;

then againſt 30 on C, is { 35.097 for Ale / 42.857 for Wine / 4.6 for Malt } on A.

EXAMPLE II.

Suppoſe A B C E F be an Elliptical Cone, whoſe Tranſverſe Diameter A C is 40 Inches, and the Conjugate Diameter E F = 36 Inches, and the Perpendicular Height B D =

51 Inches; What is the Content in Ale and Wine Gallons, and Malt Bushels.



First, Multiply 40 (the Tranverse Diameter) by 36 (the Conjugate Diameter) which makes 1440, and that multiplied by 17 ($\frac{1}{3}$ of the Height) the Product is 24480. Then,

359) 24480.000 (68.189 Content in Ale Gal.

294) 24480.000 (83.265 Content in Wine Gal.

2737.47) 24480.00000 (8.942 Content in Malt Bush.

Or, 24480 × { .002785 = 68.176 Gallons.
.0034 = 83.232 Gallons.
.000365 = 8.935 Bushels.

By

By the Sliding-Rule.

First, Find a Mean Proportional between the Transverse Diameter A C = 40, and the Conjugate Diameter F E = 36, as before directed, which you will find to be 37.947. Then,

Set { 18.94 for Ale / 17.14 for Wine / 52.32 for Malt } on C, to 17 on A;

then against 37.947 on C, is { 68.189 for Ale / 83.265 for Wine / 8.942 for Malt } on A

To Gauge a Globe.

DEFINITION.

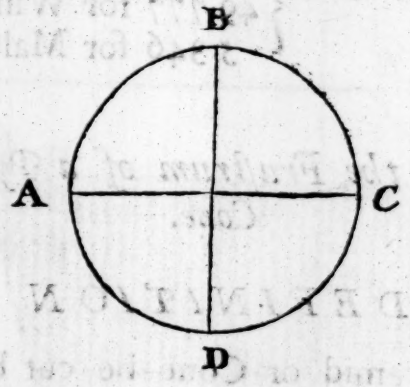
A Sphere or Globe is a Solid, bounded or included within one regular Superficies, being formed or generated by the Rotation of a Semi-circle about its Diameter, and therefore its Length, Breadth and Depth are equal.

Rule { Cube the Globe's Diameter, and divide that Cube by 538 for Ale Gallons, 441 for Wine, and 4106.2 for Malt Bushels.

EX.

EXAMPLE.

Suppose A B C D be a Globe, whose Diameter A C or B D is 28 Inches; What is the Content in Ale and Wine Gallons, and Malt Bushels?



First, Cube 28 (the Globe's Diameter) and it makes 21952. Then,

538) 21952.000 (40.802 Content in Ale Gallons.

441) 21952.000 (49.777 Content in Wine Gallons.

4106.2) 21952.0000 (5.346 Content in Malt Bushels.

By

By the Sliding-Rule.

Set { 23.19 for Ale / 21. for Wine / 64.07 for Malt } on C, to 28 on A;

then againſt 28 on C, is { 40.802 for Ale / 49.777 for Wine / 5.346 for Malt } on A.

To Gauge the Fruſtrum of a Pyramid or Cone.

DEFINITION.

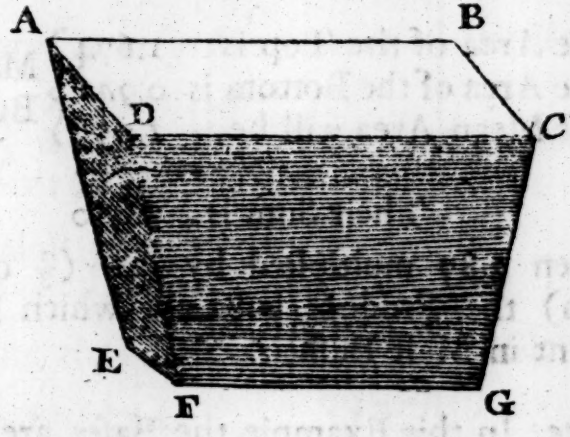
IF a Pyramid or Cone be cut by a Plane parallel to the Baſe, that which remains below is called the Fruſtrum of a Pyramid or Cone.

Rule { Find the Area of the greater Baſe and the Area of the leſſer, and then find a Geometrical Mean between thoſe two Areas, the Sum of theſe three multiplied by a third Part of the Depth gives the Content.

EXAMPLE I.

Suppoſe ABCDEFG be the Fruſtrum of a Pyramid whoſe Baſes are Rectangular Parallelograms, unequal, but parallel and the Sides

Sides ſtraight, the Length A B of the greater Baſe is 72 Inches, the Breadth B C = 50 Inches, and the Length F G of the leſſer Baſe is 54 Inches, the Breadth E F = 37.5 Inches, and the Depth 63 Inches; What is the Content in Ale and Wine Gallons, and Malt Buſhels?



The Area of the Top	12.765	Ale
The Area of the Bottom	7.18	Gal-
The Mean Area will be	9.573	lons.
Their Sum is	29.518	

Then 29.518 multiplied by 21 ($\frac{1}{3}$ of the Depth) the Product is 619.878, which is the Content in Ale Gallons.

The

The Area of the Top	15.584	Wine
The Area of the Bottom	8.766	Gal-
The Mean Area will be	11.688	lons.
Their Sum is	36.038	

Then 36.038 multiplied by 21 ($\frac{1}{3}$ of the Depth) the Product in 756.798, which is the Content in Wine Gallons.

The Area of the Top is	1.674	Malt
The Area of the Bottom is	0.941	Buſhels.
The Mean Area will be	1.255	
Their Sum is	3.870	

Then 3.87 multiplied by 21 ($\frac{1}{3}$ of the Depth) the Product is 81.27, which is the Content in Malt Buſhels.

Note, In this Example the Baſes are alike ſituate and proportional, that is, there is the ſame Proportion between the Length and Breadth of the leſſer Baſe as between the Length and Breadth of the greater Baſe. But if the Baſes had been diſproportional, whether Parallelograms or Ellipſes; or if the Top or Bottom be an Ellipſis and the other a Circle; the Content of ſuch a Tun may be truly found by the ſame General Rule above.

By

By the Sliding-Rule.

1. Set { 282 for Ale / 231 for Wine / 2150 for Malt } on A, to 50 on B;

then against 72 on A, is { 12.765 for Ale / 15.584 for Wine / 1.674 for Malt } on B.

which are the respective Areas of the Top.

2. Set { 282 for Ale / 231 for Wine / 2150 for Malt } on A, to 37.5 on B;

then against 54 on A, is { 7.18 for Ale / 8.766 for Wine / 0.941 for Malt } on B.

which are the respective Areas of the Bottom.

3. Set { 12.765 / 15.584 / 1.674 } on A, to { 12.765 / 15.584 / 1.674 } on C;

then against { 7.18 / 8.766 / 0.941 } on A, is { 9.573 / 11.688 / 1.255 } on C.

which are the Mean Areas.

The two Ends and the Mean Areas being added together, as above,

4. Set 1 on A, to 21 on B;

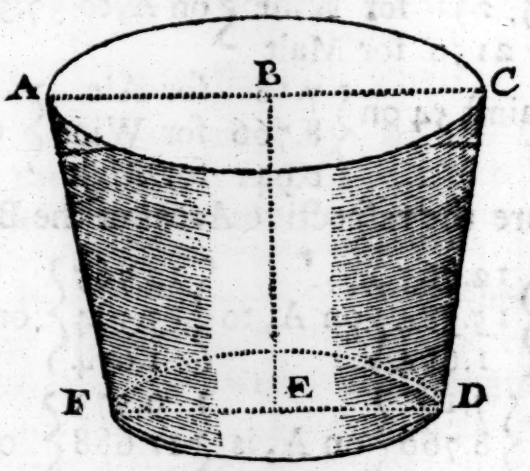
then against { 29.518 / 36.038 / 3.87 } on A, is { 619.878 / 756.798 / 81.27 } on B.

the Contents required.

EX-

EXAMPLE II.

Suppoſe ABCDEF be the Fruſtrum of a Cone, that is, a round Tun whoſe Baſes at Top and Bottom are parallel but unequal Circles, the Top Diameter AC = 48 Inches, the Bottom Diameter FD = 36 Inches, and the Depth BE = 30 Inches. What is the Content in Ale and Wine Gallons, and Malt Buſhels.



The Area of the Top	6.417	Ale Gallons.
The Area of the Botom	3.61	
The Mean Area will be	4.813	
Their Sum is	14.840.	

Then 14.84 multiplied by 10 ($\frac{1}{3}$ of the Depth) the Product is 148.4, which is the Content in Ale Gallons.

After

After the ſame manner may the Content in Wine Gallons and Malt Buſhels be found.

There is another way to find the Content of the Fruſtrum of a Cone whoſe two Ends are Circles, which is thus:

Rule. To three times the Product of the Top and Bottom Diameters, add the Square of their Difference; multiply that Sum into the Depth, and divide by 1077 for Ale Gallons, 882 for Wine, and 8212.4 for Malt Buſhels.

EXAMPLE.

Let the Tun be the ſame as above, whoſe Top Diameter is 48 Inches, the Bottom Diameter 36 Inches, and the Depth 30 Inches; What is the Content in Ale and Wine Gallons, and Malt Buſhels?

The Top Diameter is	48
The Bottom Diameter is	36
Their Product is	1728
	3
Three times their Product is	5184
The Square of 12, the Difference of the Diam. is	144
Their Sum is	5328

Then

Then 5328 multiplied by 30 (the Dept
the Product is 159840. And,

1077) 159840.000 (148.412 Content
Ale Ga
882) 159840.000 (181.224 Content
Wine G
8212.4) 159840.0000 (19.463 Content
Malt Bu

By the Sliding-Rule.

For Ale.

Set 18.94 (the Gauge-Point for Ale) o
C, to 1 on A;

Then againſt any Diameters on C, is t
Area on A.

thus againſt $\left\{\begin{matrix}48\\36\end{matrix}\right\}$ on C, is $\left\{\begin{matrix}6.417\\3.61\end{matrix}\right\}$ on A.

Then find a Mean Proportional betwee
the Areas (as before directed) which is 4.81
this added to the Areas before found,
14.84.

Then ſet 1 upon A, to 14.84 on B.

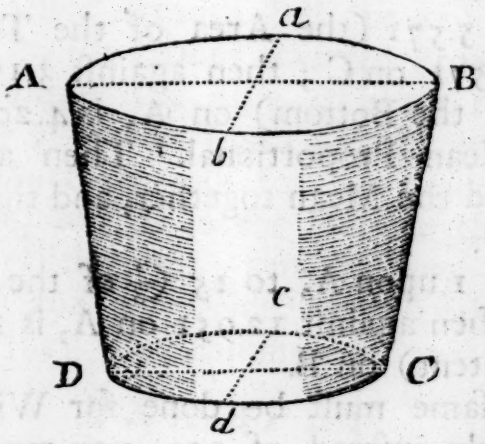
And againſt 10 on A, is 148.4, the Co
tent on B.

The ſame muſt be obſerved for Wine a
Malt, by ſetting 17.14 (the Gauge-Point f
Wine) and 52.32 (the Gauge-Point f
Malt) on C, to 1 upon A, then againſt a
Diameter on C will be the Areas on A,
above.

E

EXAMPLE III.

Suppoſe A B C D be a Tun, whoſe Baſes are Ellipſes unequal and parallel, and the Sides of the Tun ſtraight, the Length A B of the greater Baſe is 50 Inches, the Breadth $ab = 40$ Inches, the Length C D of the leſſer Baſe is 38 Inches, the Breadth $cd = 30$ Inches, and the Depth of the Tun 45 Inches; What is the Content in Ale and Wine Gallons, and Malt Buſhels?



The Area of the Top	5.571	Ale Gallons.
The Area of the Bottom	3.175	
The Mean Area will be	4.205	

Their Sum is 12.951

Then 12.951 multiplied by 15 ($\frac{1}{3}$ of the Depth) the Product is 194.265, which is the Content in Ale Gallons.

In

In like manner may the Content in Wine Gallons and Malt Buſhels be found.

By the Sliding-Rule.

For Ale.

1. Set 359 on A, to 40 on B; then againſt 50 on A, is 5.571 (the Area of the Top) on B.

2. Set 359 on A, to 30 on B; then againſt 38 on A, is 3.175 (the Area of the Bottom) on B.

3. Set 5.571 (the Area of the Top) on A, to 5.571 on C; then againſt 3.175 (the Area of the Bottom) on A, is 4.205 on C for a Mean Proportional. Then add the Areas and the Mean together, and their Sum is 12.951.

4. Set 1 upon A, to 15 ($\frac{1}{3}$ of the Depth) on B; then againſt 12.951 on A, is 194.265 (the Content) on B.

The ſame muſt be done for Wine and Malt, only inſtead of 359, you muſt make uſe of 294 for Wine, and 2737.47 for Malt.

To

To find the Content of any Tun whose Sides are straight and Bases Parallegograms or Ellipsis's another way.

RULE.

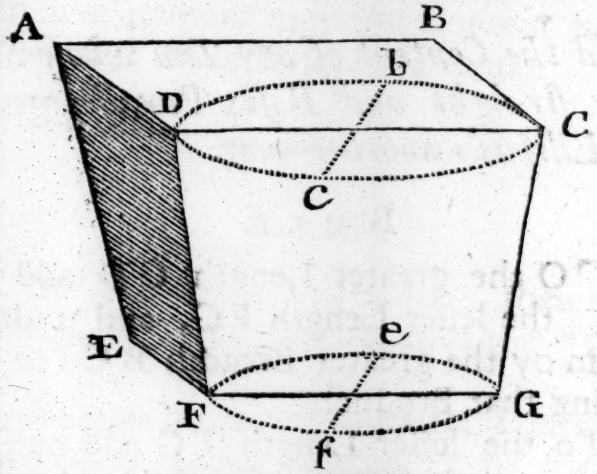
1. TO the greater Length CD add half the lesser Length FG, and multiply the Sum by the greater Breadth BC (or bc) reserving that Product.

2. To the lesser Length FG add half the greater Length CD, and multiply the Sum by the lesser Breadth EF (or ef) add this Product to the former reserved Product.

3. Multiply the Sum of these two Products by $\frac{1}{3}$ of the Tun's Depth, and divide the Product by 282 for Ale Gallons, 231 for Wine, and 2150 for Malt, if the Bases were Parallelograms; but by 359 for Ale Gallons, 294 for Wine, and 2737.47 for Malt, if they were Ellipsis's.

EXAMPLE.

Suppose ABCDEFG be a Tun whose Bases are parallel and Sides straight, the Length AB = DC of the greater Base is 70 Inches, and the Breadth BC (bc) = 60 Inches; the Length FG of the lesser Base is 56 Inches, and the Breadth EF (ef) = 40 Inches, and the Depth 57 Inches; What is the Content in Ale and Wine Gallons, and Malt Bushels?



The greater Length DC	70
Half the leſſer Length FG	28
Their Sum is	98
The greater Breadth BC (bc)	60
The Product to be reſerv'd	5880
The leſſer Length FG	56
Half the greater Length DC	35
Their Sum is	91
The leſſer Breadth EF (ef)	40
The Product is	3640
The Product above reſerv'd	5880
Their Sum is	9520
One Third of the Depth	19
The Product is	180880

Then,

Then, if the Baſes are Parallelograms,

282) 180880.000 (641.418 Content in Ale Gal.

231) 180880.000 (783.030 Content in Wine Gal.

2150) 180880.000 (84.130 Content in Malt Buſh.

If the Baſes are Ellipſis's, then

359) 180880.000 (503.844 Content in Ale Gal.

294) 180880.000 (615.238 Content in Wine Gal.

2737.47) 180880.00000 (66.075 Content in Malt Buſh.

To Gauge Malt by a Line on the Sliding-Rule mark'd with M D, *ſignifying Malt Depth.*

HAving taken the Depth in 6, 8, or 10 Places, add all theſe Depths together, and divide the Sum by the Number of Places in which the Depths were taken, the Quotient will be the Mean Depth. Then,

Set the Mean Depth upon the Line M D,
To the Length or Breadth upon B;
And againſt the Length or Breadth upon A,
Is the Content in Malt Buſhels upon B.

EXAMPLE.

Suppoſe a Floor whoſe Length is 150 Inches, the Breadth 134 Inches, and the Mean Depth 9.2 Inches; What is the Content in Malt Buſhels?

Set 9.2 on MD to 150 on B,
And againſt 134 on A is 86 (the Content) on B.

Or thus,

Set 9.2 on MD to 134 on B,
And againſt 150 on A is 86 (the Content) on B.

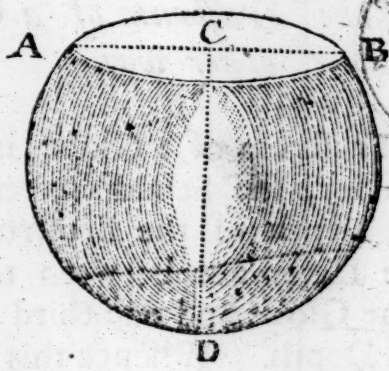
To Gauge the Fruſtrum of a Globe.

Rule { To three times the Square of the Fruſtrum's Diameter, add four times the Square of the Depth, multiply that Sum by the Depth, and divide the Product by 2154 for Ale Gallons, 1764 for Wine, and 1642.82 for Malt Buſhels.

EXAMPLE.

Suppoſe ABCD be the Fruſtrum of a Globe whoſe Diameter AB is 31 Inches, and the Depth CD is 35 Inches; What is the Content in Ale, Wine, and Malt?

Three



Three times the Square of A B is	2883
Four times the Square of C D is	4900
Their Sum is	7783
The Depth C D is	35
The Product is	272405

Then,

2154) 272405.000 (126.464	Content in Ale Gal.
1764) 272405.000 (154.424	Content in Wine Gal.
16424.8) 272405.0000 (16.584	Content in Malt Bush.

To Gauge the Fruſtrum of a Globe, another way.

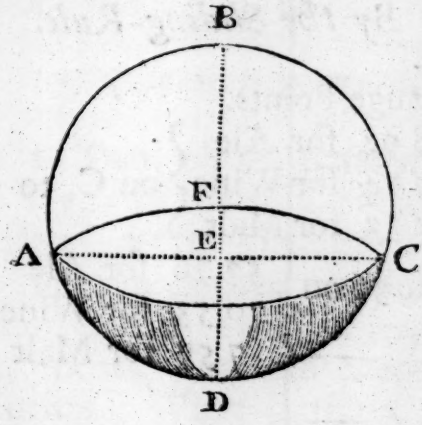
THE Fruſtrum of a Globe is equal to a Cylinder, the Semidiameter of whoſe Baſe is the Depth of the Fruſtrum, and its Height the Difference between the Semidiameter of the Globe and one third Part of the Fruſtrum's Depth. Whence this Rule:

Rule { Multiply the Square of double the Depth, by the Difference of the Globe's Semidiameter and a third Part of the Depth, and divide the Product by 359 for Ale Gallons, 294 for Wine, and 2737.47 for Malt Buſhels.

EXAMPLE.

Suppoſe AECD be the Fruſtrum of a Globe whoſe Depth ED is 18 Inches, and the Diameter of the Globe BD is 44 Inches; What is the Content in Ale and Wine Gallons, and Malt Buſhels?

The



The Square of (36) twice the Depth E D is	1296
The Difference between the Globe's Semidiameter F D = 22 and $\frac{1}{3}$ of the Depth E D is	16
Their Product is	20736

Then,

359	) 20736.00	(57.76	Content in Ale Gal.
294	) 20736.00	(70.53	Content in Wine Gal.
2737.47)	20736.000	(7.57	Content in Malt Bush.

By the Sliding-Rule.

Gauge Points.
Set { 18.94 for Ale / 17.14 for Wine / 52.32 for Malt } on C, to 16 on A;
then againſt 36 on C, is { 57.76 for Ale / 70.53 for Wine / 7.57 for Malt } on A.

To Inch a Tun whoſe Sides are ſtraight from the Top to the Bottom.

RULE.

FIRST find the whole Content of the Tun, as before directed, then divide the Difference between the Top and Bottom Area's by the Depth of the Tun, and the Quotient will be an *Addend* or *Fix'd Number*, the half of which being added to the leſſer Area, the Sum will be the Area at one Inch; and the whole Fix'd Number being added to that Area, will be the Area of the ſecond Inch; and the ſame Fix'd Number being added to that Area, will be the Area of the third Inch; and ſo on from Inch to Inch, till the Area of every ſingle Inch be found; the Sum of thoſe Area's will be equal (or nearly

nearly equal) to the Content, as above, if the Work be true.

EXAMPLE.

Suppoſe a Tun whoſe Baſes are unlike, that is to ſay, the lower Circular and the upper Elliptical, let the Diameter of the Circular Baſe be 100 Inches, the longeſt Diameter of the Ellipſis 100 Inches, and the ſhorteſt 90 Inches, and the Depth of the Tun 20 Inches; What is the Content at every Inch?

The Area of the Top is	25.069	Ale Gallons.
The Area of the Bottom is	27.855	
The Mean Area will be	26.425	
Their Sum is	79.349	
One Third of the Depth is	6.6666	
Their Product is	528.988	

which is the whole Content in Ale Gallons.

The Area of the Top being ſubtracted from the Area of the Bottom, their Difference is 2.786, which divided by 20, (the Depth of the Tun) the Quotient is .139 for the Addend or fixed Number.

Then .069 (the half of .139) added to 25.069, is 25.138, the Area at one Inch; and .139, (the whole fix'd Number) added to 25.138, is 25.277, the Area of the ſecond Inch; and .139 added to 25.277, is 25.416, the Area of the third Inch; in like manner, the Area of every Inch of the Depth is found by adding .139 to the laſt Area. Laſtly, Add the ſeveral Areas together, and the Sum is 529.17, which is very near the Content found, as above.

Depth	Area of every Inch
	Ale Gal.
1	25.138
2	25.277
3	25.416
4	25.555
5	25.694
6	25.833
7	25.972
8	26.111
9	26.250
10	26.389
11	26.528
12	26.667
13	26.806
14	26.945
15	27.084
16	27.223
17	27.362
18	27.501
19	27.640
20	27.779
	529.170

'Tis plain from hence, that if 1, 2, 3, 4, or any Number of thoſe Area's accounted from the Bottom be added together, their Sum will ſhew the Quantity of Liquor or Drink that is in the Tun, to ſuch a Number of Wet Inches from the Bottom, as there were Area's added together.

Or,

Or, if the Sum of any Number of those Area's accounted from the Top be subtracted from the Tun's whole Content, the Remainder will shew what Quantity of Liquor or Drink is in the Tun when there is such a Number of Dry Inches from the Top as there were Area's subtracted.

Dep.	Cont. in Ale Gal.	Content in Bar.	Fir.	Gal.
0	529.170	15	2	2.1
1	504.032	14	3	2.5
2	478.755	14	0	2.7
3	453.339	13	1	2.8
4	427.784	12	2	2.7
5	402.090	11	3	2.5
6	376.257	11	0	2.2
7	350.285	10	1	1.7
8	324.174	9	2	1.1
9	297.924	8	3	0.4
10	271.535	7	3	8
11	245.007	7	0	7
12	218.340	6	1	5.8
13	191.534	5	2	4.5
14	164.589	4	3	3
15	137.505	4	0	1.5
16	110.282	3	0	8.2
17	82.920	2	1	6.4
18	55.419	1	2	4.3
19	27.779	0	3	2.2
20	0.000	0	0	0

The Use of this Table is plain to the meaneſt Capacity, for if you come to this Tun and find 4 Inches of the Depth dry, the Quantity of the Liquor then in the Tun is 427.784 Gallons. If 11 Inches be dry, there remain in the Tun 245.007 Gallons, or 7 Barrels, 0 Firkins, 7 Gallons.

To Inch a Tun whoſe Sides are not ſtraight from the Top to the Bottom.

Rule.

DIvide or part the Tun into ſeveral Fruſtrums, each of 10 Inches deep; and find the Content of every ſingle Fruſtrum by taking the Diameters in the Middle of every one of thoſe 10 Inches, that is the firſt Diameter at 5 Inches from the Top, the ſecond Diameter at 15 Inches from the Top, *&c.*) and multiply their reſpective Area's by 10, (which is done by removing the ſeparating Point one Place forward to the Right Hand) then the Sum of all thoſe Fruſtrums will be the whole Content of the Tun.

Then from the whole Content of the Tun ſubtract the Mean Area of the firſt Fruſtrum continually, till you come at the 10th Inch of the Tun's Depth, and from that Remainder ſubtract the Mean Area of the ſecond Fruſtrum continually, till you come at the 20th Inch of the Tun's Depth, and from that Remainder ſubtract the Mean Area of the third Fruſtrum, *&c.* and, if your Work be right, there will be no Remainder at the laſt Inch or Bottom of the Tun.

EX-

EXAMPLE.

Suppoſe a Tun whoſe Diameter at the Bottom is 108 Inches, the Diameter at the Top 93 Inches, and the Depth 30 Inches; How many Ale Gallons will this Ton contain upon every Inch of the Depth?

Take

Take the Diameters at 5, 15, 25 Inches Depth ſeverally, which ſuppoſe, in this Example, to be 95.5 Inches the Firſt, 100.5 the Second, and 105.5 the Third; then the Areas, either by the Pen or Sliding-Rule, are found to be 25.4 the Firſt, 28.13 the Second, and 31 the Third, and their Contents at 10 Inches deep will be 254 Gallons the Firſt, 281.3 Gallons the Second, and 310 Gallons the Third; and theſe added together, their Sum is 845.3 Gallons, the whole Content of the Tun.

Then from 845.3 ſubtract 25.4 (the firſt Mean Area) and from that Remainder ſubtract 25.4 again, and ſo on till you come at the 10th Inch, and there the Remainder will be 591.3.

Then from 591.3 ſubtract 28.13 (the ſecond Mean Area) and from that Remainder ſubtract 28.13, and ſo on continually till you come at the 20th Inch, and there the Remainder is 310.

Laſtly,

Depth	Cont. in Ale Gal.
0	845.3
1	819.9
2	794.5
3	769.1
4	743.7
5	718.3
6	692.9
7	667.5
8	642.1
9	616.7
10	591.3
11	563.17
12	535.04
13	506.91
14	478.78
15	450.65
16	422.52
17	394.39
18	366.26
19	338.13
20	310.
21	279.
22	248.
23	217.
24	186.
25	155.
26	124.
27	93.
28	62.
29	31.
30	0.

Laſtly, From 310 ſubtract 31 (the Third Mean Area) and from that Remainder ſubtract as before, till you come to the 30th Inch, which is the Bottom of the Tun, and the Remainder is 0.

The Uſe of this Table is obvious from what hath been ſaid already.

Note, That moſt Brewer's Tuns are ſo fix'd as to lean a little, for Conveniency of cleanſing their Drink, which is uſually called the Drip or Fall of the Tun; and the Practical way of finding its Content, is to meaſure into the Tun (when it is dry) ſo much Liquor as will juſt cover its Bottom, by which means you not only find the true Fall, but alſo the Horizontal or Level Plane over the Bottom of the Tun, from which, if the neareſt Diſtance from the Top of the Tun to the Surface of the Liquor be ſet off upon every one of its Sides, you will then have a parallel Plane at the Top of the Tun to that of the Liquor.

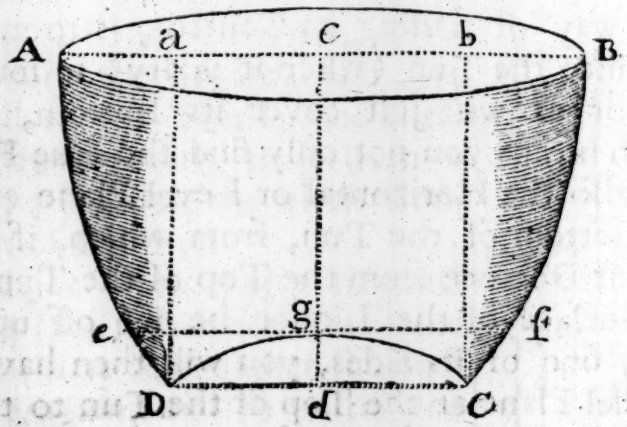
Then having found, as before, ſo much of the Tun's Content as is betwixt thoſe two Planes, add it to the Tun's Drip or Fall, and that Sum will be the whole Content of the Tun.

And if ſo much of the Tun's Content as is betwixt thoſe two Planes be inched as is before directed, and 1, 2, 3, 4, or any Number of thoſe Areas accounted from the Bottom, be added to the Fall, that Sum will ſhew

ſhew the Quantity of Liquor that is in the Tun.

To Gauge a Copper, and make Allowance for the Crown.

SUppoſe A B C D be a Copper to be gaug'd, the Dimenſions may be taken, and the Content found as below.



Take a ſmall Cord or Thread and faſten it at A, and extend the other End to the oppoſite Side of the Copper at B, where faſten it, or cauſe ſome Perſon to hold it ſtraight, then ſet one End of your Inſtrument at D, and move it towards A or B, till you find the neareſt Diſtance to the Thread as at a; this Diſtance D a is the Depth of the Copper, ſuppoſe it be 50 Inches.

In

In like manner ſet one End of your Inſtrument upon the Top of the Crown at *g*, and take the neareſt Diſtance to the Thread, as *g c*, ſuppoſe it be 42 Inches; which ſubtracted from D a = 50 Inches, the Remainder is 8, which is the Height of the Crown.

Then meaſure A B the Diameter at the Top, which ſuppoſe is 110 Inches, and hold a Thread ſo as a Plummet at the end thereof may hang juſt over D, which it will do when at a; then meaſure A a which is equal to B b, ſuppoſe each be 15.5 Inches: Add theſe together and ſubtract 31 Inches their Sum from A B = 110 Inches, the Remainder 79 Inches is equal to D C the Diameter at the Bottom of the Crown; the Diameter *e f* which touches the Top of the Crown may be found by the Inſtrument ſuppoſe it be 85.6 Inches.

Now to find the Content of the Copper from the Crown upwards (that is, the Part A B *e f*) the Depth *c g* being 42 Inches, you may take a Diameter in the middle of every 6 Inches betwixt *c* and *g*, which ſuppoſe to be as in the 2d Column of the following Table; then find (by the Ale Gauge Point upon the Sliding-Rule) the Areas of thoſe ſeveral Diameters, and ſet them againſt their proper Diameters in the 3d Column; having ſo done, the 4th Column is made by multiplying each Area by 6, which gives the Content at every 6 Inches of the Depth *c g*, which

which added together makes 32 Barrels, Firkins, 7.21 Gallons.

Parts of the Depth.	Diameters.	Areas of those Diameters.	Content of every 6 Inches reduced to *Bar.*	*Firk.*	*Gal.*
6	108.9	33.03	5	3	2.65
6	105.1	30.76	5	1	6.05
6	101.2	28.52	5	0	1.08
6	97.3	26.37	4	2	5.2
6	93.4	24.29	4	1	1.22
6	90.6	22.86	4	0	1.15
6	86.8	20.98	3	2	6.86
42	Sum		32	3	7.21
To cover the Crown			2	1	4.1
Content of the Copper			35	1	2.81

To find the Quantity of Liquor that will cover the Crown of the Copper (that is, the Part *e*D*g*C*f*.)

Rule { From the Area of the Plane at the Top of the Crown ſubtract 1 $\frac{1}{3}$ of the Area of the Crown's Height and multiply the Remainder by half the Height of the Crown, and the Product is the Number of Gallons that will cover the Crown.

By the Diameter *ef* = 85.6 Inches, the Area of the Plane at the Top of the Crown is found to be 20.41 Gallons; and by the Diameter

Diamete $gd = 8$ Inches, the Area of the Crown's Height is found to be .178 Gallons, $\frac{1}{3}$ of which ſubtracted from 20.41 Gallons the Remainder is 20.173, and this multiplied by 4 (half the Height of the Crown) the Product is 80.692, which is the Content of the Part $eDgCf$, and ſo much Liquor the Crown will take to cover it, which is 2 Barrels, 1 Firkin, 4.1 Gallons.

Add the Content of the Part $ABef$, *viz.* 32 Barrels, 3 Firkins, 7.21 Gallons, to the Content laſt found, and the Sum will be the whole Content of the Copper $ABCgD$, *viz.* 35 Barrels, 1 Firkin, 28½ Gallons.

A Copper is inched by the ſame Method as is before ſhewn for inching of Tuns.

Of Cask-Gauging.

BEfore we can find the Content of a Cask, the three following Dimenſions muſt be truly taken in Inches and Decimal Parts of an Inch, *viz.*

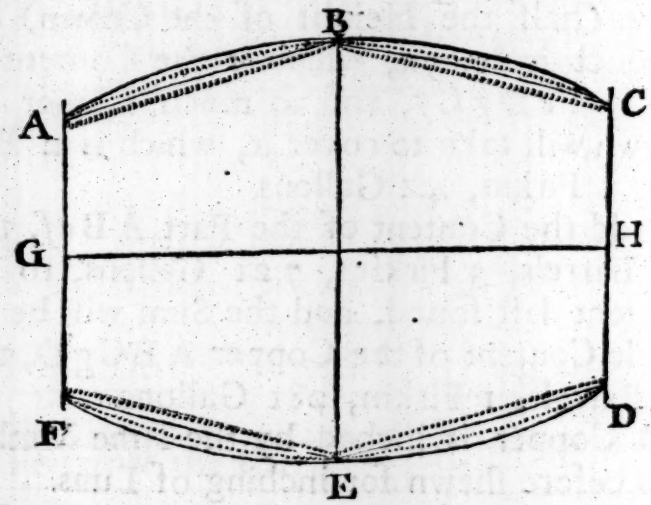
The Diameter at the Bung.

The Diameter at the Head.

And the Length.

When theſe Dimenſions are known, the Form or Shape of the Cask muſt be conſidered; for it will be eaſy to perceive by the following Figure that the Diameters (aboveſaid) and the Length of one Cask may be equal

equal to thoſe of another, and yet one of thoſe Casks may contain ſeveral Gallons more than the other.



In this Figure it is plain, that if the outward curved Lines A B C and D E F are the Bounds or Staves of a Cask, it muſt needs hold more than if the inner curved or ſtraight Lines were its Bounds or Staves; and yet the Bung Diameter B E, the Head Diameters A F and C D, and the Length G H, are the ſame in all the Casks.

The plaineſt and eaſieſt way to find the Content of any Cask, is, by finding ſuch a *mean Diameter* as will reduce the propoſed Cask to a Cylinder: Thus,

Rule

Rule { Multiply the Difference between the Head and Bung Diameters with .7, or with .65, or with .6, or with .55, according as the Staves of the Cask are more or leſs arching; add the Product to the Head Diameter, and the Sum will be the Mean Diameter required. Then find the Content, as before, at Page 81.

EXAMPLE I.

Suppoſe a Cask whoſe Staves are very much arching, the Bung Diameter is 32 Inches, the Head Diameter 24 Inches, and its Length 44 Inches: What is the Content in Ale and Wine Gallons?

Bung's Diameter is	32
Head Diameter is	24
Their Difference	8
Multiplied by .7	.7
The Product is	5.6
The Head Diameter	24.0
Their Sum, which is the mean Diameter required,	29.6

Then

Then 29.6 ſquared, is 876.16, this multiplied by 44 (the Length) the Product is 38551.04, and,

359) 38551.040 (107.384 Content in Ale Gallons.

294) 38551.040 (131.125 Content in Wine Gallons.

Or, 38551 × { .002785 = 107.364 Gallons. / .0034 = 131.073 Gallons.

By the Sliding-Rule.

Having found (by the Pen) the Mean Diameter,

Set { 18.94 for Ale / 17.14 for Wine } on C, to 44 on A;
then againſt 29.6 on C, is { 107.38 for Ale / 131.12 for Wine } on A.

EXAMPLE II.

Suppoſe a Cask whoſe Staves are almoſt ſtraight, and the Dimenſions the ſame as in the laſt Example: What is the Content in Ale and Wine Gallons?

The

The Difference of the Bung and Head Diameters is } 8
Multiplied by .55 .55

The Product is 4.40
The Sum of the Product and Head Diameter } 28.40

Then 28.4 ſquared is 806.56, this multiplied by 44 (the Length) the Product is 35488.64, and

359) 35488.640 (98.854 Content in Ale Gallons.

294) 35488.640 (120.709 Content in Wine Gallons.

Or, $35488.64 \times \begin{cases} .002785 = 98.835 \text{ Gal.} \\ .0034 = 120.661 \text{ Gal.} \end{cases}$

By the Sliding-Rule.

Having found the Mean Diameter, as before,

Set { 18.94 for Ale / 17.14 for Wine } on C, to 44 on A;
then againſt 28.4 on C, is { 98.85 for Ale / 120.7 for Wine } on A.

In like manner muſt the Difference between the Bung and Head Diameters be multiplied by .65 or .6, according as the Staves are more or leſs arching.

To

To find the Ullage of a Cask when its Axis is parallel to the Horizon.

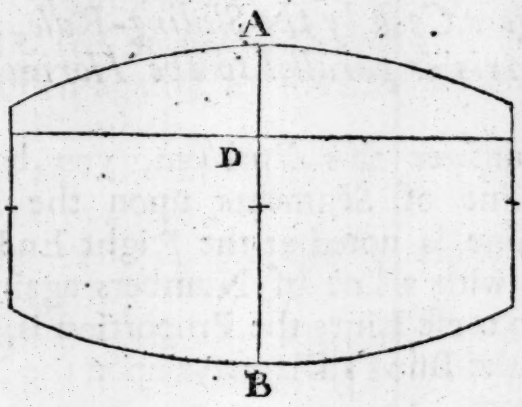
Rule Divide either the Wet or Dry Inches by the Bung's Diameter, and the Quotient ſeek in the Table of the Segments of a Circle, under V. S. or Verſed Sine, againſt it ſtands a Number, which multiplied by the Content of the Cask, the Product gives the Quantity of Liquor in the Cask, if the Dividend were the Wet Inches, or the Vacuity if it were the Dry.

Note, There is a Table of the Segments of a Circle inſerted at Page 68.

EXAMPLE I.

Suppoſe the Figure following repreſent a Cask lying with its Axis parallel to the Horizon, partly empty; let the Bung's Diameter A B be 40 Inches, and the Content of the Cask 140 Gallons; let D B be the Wet Inches = 29, and A D the Dry = 11; I demand how many Gallons are in the Cask?

The



The Wet Inches are 29, which divide by 40, and the Quotient is .72, find this under V. S. in the Table, and againſt it (under the Word Area) is .7708; which multiplied by 140 (the Cask's Content) the Product is 107.912, the Quantity of Liquor in the Cask.

EXAMPLE II.

Suppoſe in the ſame Cask as before, the Dry Inches are = 18 and the Wet = 22, I demand how may Gallons are drawn out of the Cask?

Divide 18 (the Dry Inches) by 40 (the Bung's Diameter) and the Quotient is .45, find this under V. S. in the Table, and againſt it is .4364, which multiplied by 140 (the Cask's Content) the Product is 61.096, the Quantity of Liquor drawn out of the Cask.

To Ullage a Cask by the Sliding-Rule, when its Axis is parallel to the Horizon.

TO anſwer this Problem, you have a Line of Segments upon the Rule, which Line is noted at the Right End with Seg. l. y. with a line of Numbers againſt it, and upon theſe Lines the Proportion is,

1. As the Bung's Diameter upon the Numbers
   Is to 100 upon the Segments;
   So are the Wet or Dry Parts on the Numbers,
   To a Fourth Number on the Segments.
2. As 100 upon A
   Is to the Cask's whole Content upon B;
   So is the fourth Number laſt found on A,
   To the Anſwer on B.

EXAMPLE.

Suppoſe a Cask be in the Form of the Middle Fruſtrum of a Spheroid, whoſe Bung Diameter is 34 Inches, the Wet Part 26 Inches, the Dry Part 8 Inches, and the whole Content 128.71 Gallons; How many Gallons are contain'd in the Cask, and how many Gallons will it require to fill it full?

1. Set

1. Set 34, the Bung's Diameter, on the Numbers
   To 100 on the Segments;
   Then againſt 8, the Dry Inches on the Numbers,
   Is 16 on the Segments.
2. Set 100 upon A
   To 128.71, the Cask's whole Content, on B;
   Then againſt 16 upon A,
   Is 20.6 upon B.

And ſo many Gallons it will take to fill up the Cask: This ſubtracted from 128.71, the whole Content, the Remainder 108.11, is the Quantity of Liquor in the Cask.

Or otherwiſe thus,

1. Set 34, the Bung's Diameter, on the Numbers,
   To 100 on the Segments;
   Then againſt 26, the Wet Inches on the Numbers,
   Is 84 on the Segments.
2. Set 100 on A
   To 128.71 on B;
   Then againſt 84 on A,
   Is 108.11 on B.

Which being the ſame as before, is a Proof of the Work.

To find the Ullage of a Cask when its Axis is perpendicular to the Horizon.

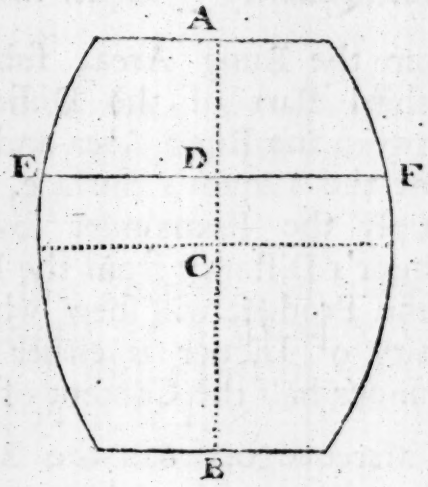
IN order to this it is neceſſary to know how to find the Area of any Circle betwixt the Bung and Head, whoſe Diſtance from the Bung or Middle of the Cask is given, which may be done by this Rule.

Rule { Multiply the Difference between the Bung and Head Area's by the Square of any Circle's Diſtance from the Bung, and divide that Product by the Square of half the Length of the Cask; then ſubtract the Quotient from the Bung Area, and the Remainder is the Area of the Circle requir'd, *viz.* the Area of the Liquor's Surface.

EXAMPLE.

Suppoſe a Cask whoſe Bung Diameter is 32 Inches, the Head Diameter 24 Inches, and its Length 44 Inches; I demand what Quantity of Liquor is in it (of Ale Meaſure) when there are but 30 Inches Wet?

The



The Bung Area is	2.852
The Head Area is	1.604
Their Difference is	1.248
The Diſtance CD = 30 — 22 is 8, whoſe Square is	64
Their Product is	79.872

This Product divided by 484 (the Square of half the Length of the Cask) the Quotient is .165 which ſubtracted from 2.852 (the Bung Area) the Remainder is 2.687, which is the Area of the Circle whoſe Diameter is E F, that is, the Area of the Liquor's Surface.

To find the Quantity of Liquor in the Cask.

Rule { From the Bung Area, ſubtract one third Part of the Difference between the Bung Area and the Area of the Liquor's Surface, and multiply the Remainder by the Liquor's Diſtance from the Bung, and the Product will ſhew what Quantity of Liquor is either above or under half the Content of the Cask.

The Difference between the Bung Area and the Area of the Liquor's Surface, as before found, is .165, a third Part of which is .055, this ſubtracted from 2.852 (the Bung Area) the Remainder is 2.797, which multiplied by 8 (the Liquor's Diſtance from the Bung) the Product is 22.376 Gallons, and ſo much the Cask is more than half full, therefore 22.376 added to 53.692 (half the Content of the Cask) the Sum is the Quantity of Liquor in the Cask at 30 Inches Wet, *viz.* 76.068 Ale Gallons; if this be taken from 107.384 (the whole Content) there remains 31.316, and ſo many Gallons are requir'd to fill up the Cask.

If the Cask were leſs than half full, you muſt find (by the ſame Rule) how much it is leſs than half full, and *ſubtract* that from half the Content of the Cask and the Remainder

mainder will be the Quantity of Liquor in the Cask.

To Ullage a Cask by the Sliding-Rule, when its Axis is perpendicular to the Horizon.

FOR this Purpoſe you have a Line of Segments for a ſtanding Cask noted with Seg. s. t. with a Line of Numbers againſt it, and upon theſe Lines the Proportion is:

1. As the Cask's Length upon the Numbers
   Is to 100 on the Segments;
   So are the Wet or Dry Parts on the Numbers,
   To a fourth Number on the Segments.
2. As 100 upon A
   Is to the Cask's whole Content upon B;
   So is the fourth Number laſt found on A,
   To the Anſwer on B.

EXAMPLE.

Suppoſe a Cask be in the Form of the middle Fruſtrum of a Spheroid whoſe Length is 38 Inches, the Wet Part 23 Inches, the Dry Part 15 Inches, and the whole Content 80.58 Gallons; How many Gallons are in the Cask, and how many Gallons will it require to fill it full?

1. Set 38, the Cask's Length on the Numbers,
   To 100 on the Segments;
   Then againſt 23, the Wet Inches on the Numbers,
   Is 615 on the Segments.
2. Set 100 on A
   To 80.58, the Cask's Content, on B;
   Then againſt 61.5 on A,
   Is 49.57 on B.

And ſo much Liquor is now in the Cask.

For the Vacuity, or the Liquor wanting to fill it full;

1. Set 38, the Cask's Length on the Numbers,
   To 100 on the Segments;
   Then againſt 15, the Dry Inches on the Numbers,
   Is 38.2 on the Segments.
2. Set 100 upon A
   To 80.58, the Cask's Content, on B;
   Then againſt 38.2 on A,
   Is 31.01 on B.

Which is the Quantity of Liquor requir'd to fill the Cask.

Note, There is placed upon one Side of the Sliding-Rule, a Line of Inches, and under it three Varieties of Casks: The Uſe of theſe Lines is to reduce any Cask to a Cylinder, which is done thus; Seek the *Difference*

rence between the Bung and Head Diameters in the Line of Inches, and againſt it you have a *Number*, which added to the Head Diameter, the Sum will be the Diameter of an equal Cylinder. The Content is found as before directed, at Page 81.

Note alſo, There is placed on the Backſide of two Slides, a Line of Inches, and againſt it a Line of *Circles Areas* in Ale Gallons, whereby you not only may take Dimenſions with great Eaſe and Speed, but you have alſo the Area of any Circle by Inſpection whoſe Diameter is given in Inches.

To compute the Exciſe of any Number of Barrels, according to the reſpective Allowances made to common Brewers both in London *and the Country.*

THE Exciſe for common Brewers in the Country is 5 *s.* per Barrel for Strong Beer, and 1 *s.* 4 *d.* per Barrel for Small Beer; the Allowance being 2 $\frac{1}{2}$ Barrels in every 23; therefore the Duty paid for 1 Barrel of Strong Beer is .222826 of a Pound, and the Duty for 1 Barrel of Small Beer is .05942 of a Pound. Whence this Rule:

Rule { Multiply the given Number of Barrels by .222826 for Strong Beer, and by .05942 for Small Beer, and the Product is the Duty to be paid.

EXAMPLE I.

What is the Duty of 97 Barrels of Strong Beer?

.222826
97
1559782
2005434
21.614122

l. *s.* *d.*
which reduced, is 21 12 3 ¼

EX.

EXAMPLE II.

What is the Duty of 667 Barrels of Small Beer?

.05942
667

41594
35652
35652

39.63314

l. *s.* *d.*
which reduced, is 39 12 8

The Exciſe for common Brewers in *London* is 5 *s.* per Barrel for Strong Beer and Ale, and 1 *s.* 4 *d.* per Barrel for Small Beer; the Allowance being 3 Barrels in every 23 for Strong and Small Beer, and 2 Barrels in every 22 for Ale; therefore the Duty paid for 1 Barrel of Strong Beer is .217391 of a Pound; the Duty of 1 Barrel of Ale is .227272 of a Pound, and the Duty of a Barrel of Small Beer is .057971 of a Pound. Whence this Rule:

Rule { Multiply the given Number of Barrels by .217391 for Strong Beer, by .227272 for Ale, and by 057971 for Small Beer, and the Product is the Duty to be paid.

EXAMPLE I.

What is the Duty of 329 Barrels of Strong Beer?

```
  .217391
      329
 ---------
  1956519
   434782
   652173
 ---------
 71.521639
```

	l.	*s.*	*d.*
which reduced, is	71	10	5

EX-

EXAMPLE II.

What is the Duty of 91 Barrels of Ale?

.227272
91
227272
2045448
20.671752

l. *s.* *d.*
which reduced, is 20 13 7 $\frac{1}{2}$

EXAMPLE III.

What is the Duty of 73.5 Barrels of Small Beer?

.057971
73.5
289855
173913
405797
4.2607685

l. *s.* *d.*
which reduced, is 4 5 2 $\frac{1}{2}$

Where

Where there is no Allowance, as to Victuallers in the Country, obſerve this Rule:

Rule { Divide the Number of Barrels by 4 for Strong Beer, and by 15 for Small Beer, and the Quotient is the Duty to be paid.

EXAMPLE I.

What is the Duty of 166 Barrels of Strong Beer or Ale at 5 *s.* per Barrel?

	l.	*s.*	*d.*
4) 166 (	41	10	0

Note, The Remainder is always ſo many Crowns.

EX-

EXAMPLE II.

What is the Duty of 876 Barrels of Small Beer at 1 *s.* 4 *d.* per Barrel?

	l.	*s.*	*d.*
15) 876 (	58	8	0
75			
126			
120			
6			

Note, The Remainder is always so many times 1 *s.* 4 *d.*

FINIS.

ERRATA.

PAge 5, l. 6, r. *Numbers*. p. 9, l. 17, r. *Diviſor*. p. 10, l. 4. r. 3.97. p. 11, l. 5, for *are*, r. *is*. p. 24, l. 25, r. *Subtract*. p. 30, l. 5, r. 1 *and* 2. l. 23, for .1 in the fifft Column, r. .01. p. 38, l. 2. r. .484 *upon A*. p. 54, l. 3, r. 2.235 *Buſh*. p. 90, l. 6, for *in*, r. *is*. p. 100, l. 19, r. 16424.8. p. 115, l. 14, r. 2.81 *Gallons*.

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be wise friend will
be?
P.S. Not to my Nor
Nice for

Know when to Speak & whe
to Silent Sit